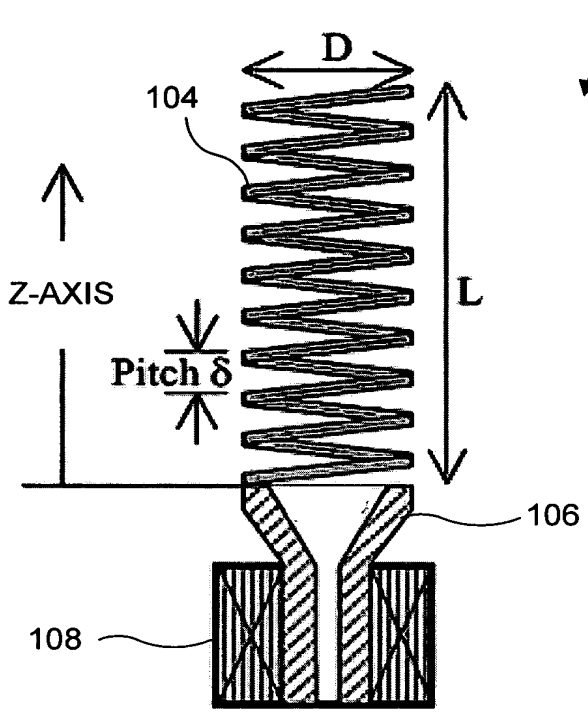


FIG. 1A
PRIOR ART

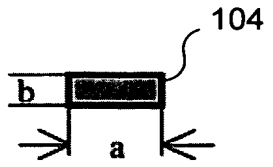


FIG. 1B
PRIOR ART

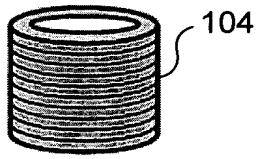


FIG. 1C
PRIOR ART

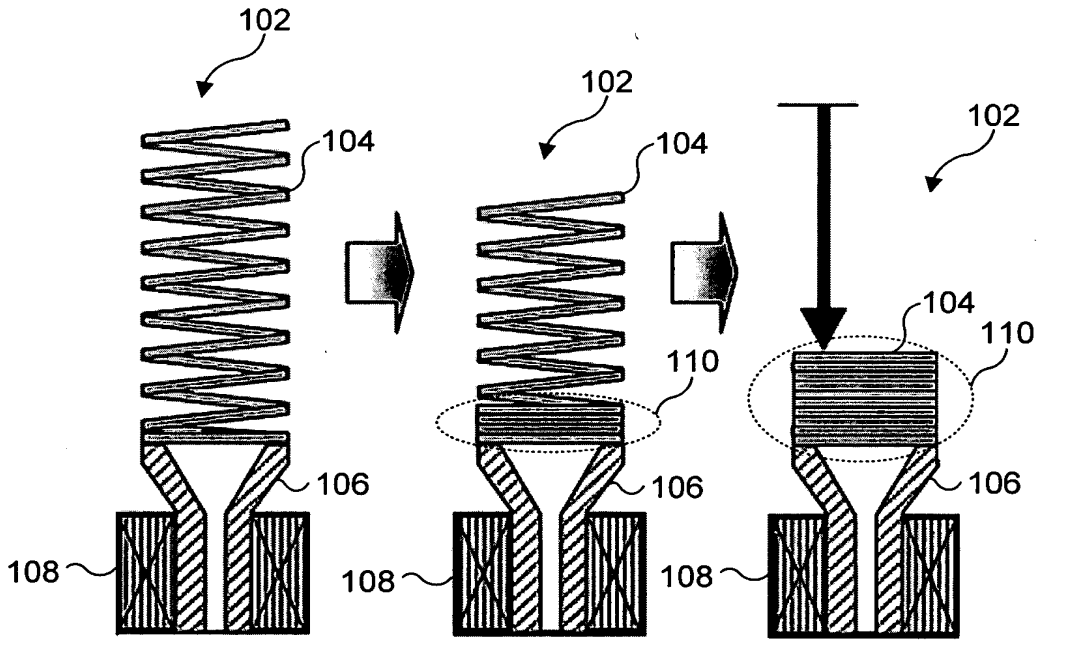


FIG. 2A FIG. 2B FIG. 2C

PRIOR ART

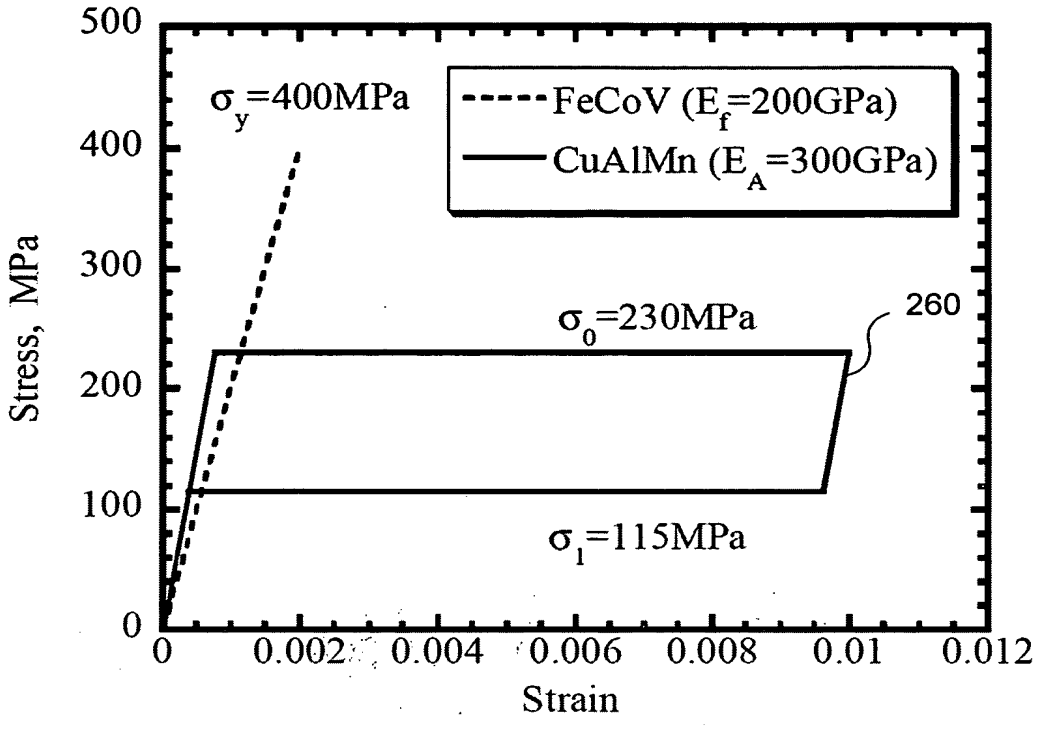


FIG. 3

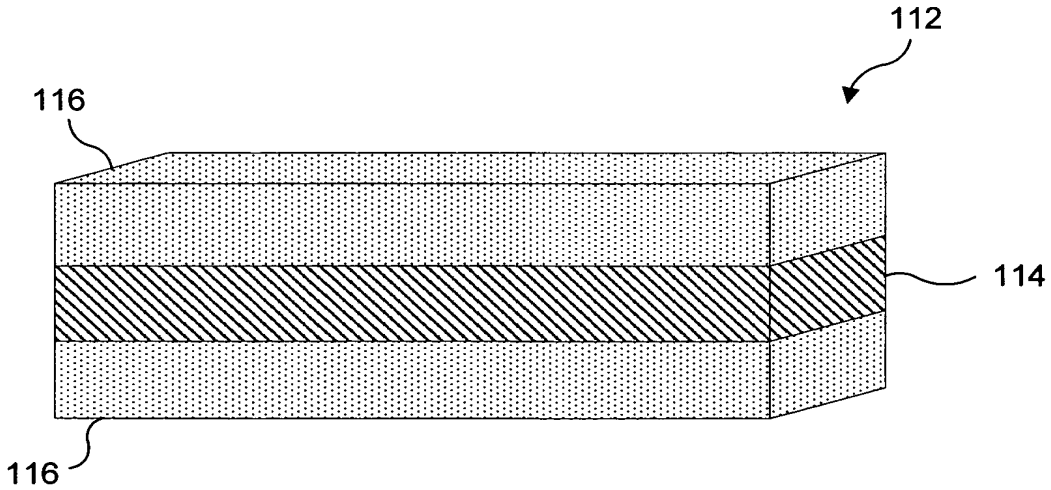


FIG. 4
PRIOR ART

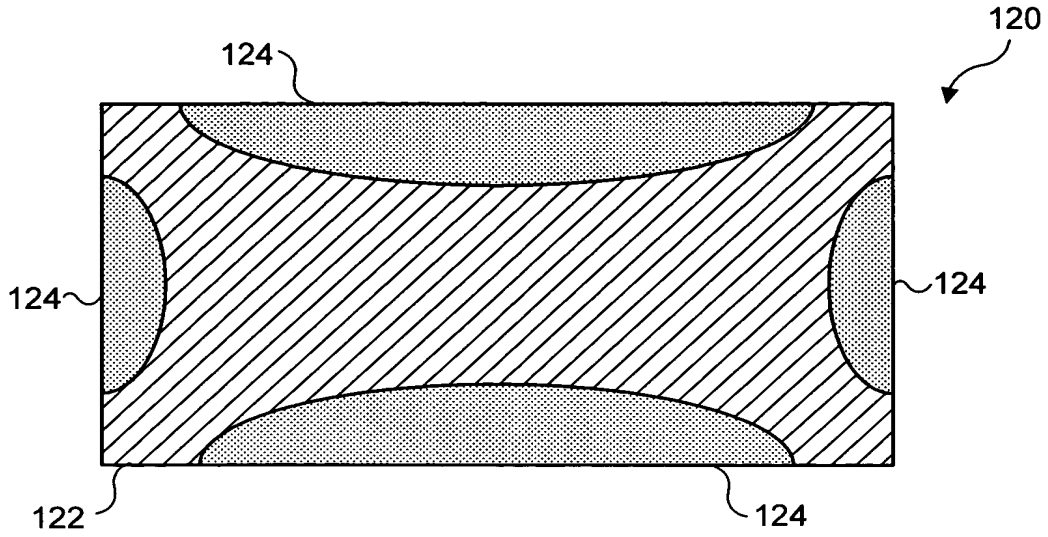

120
124
124
124
122
124

FIG. 5

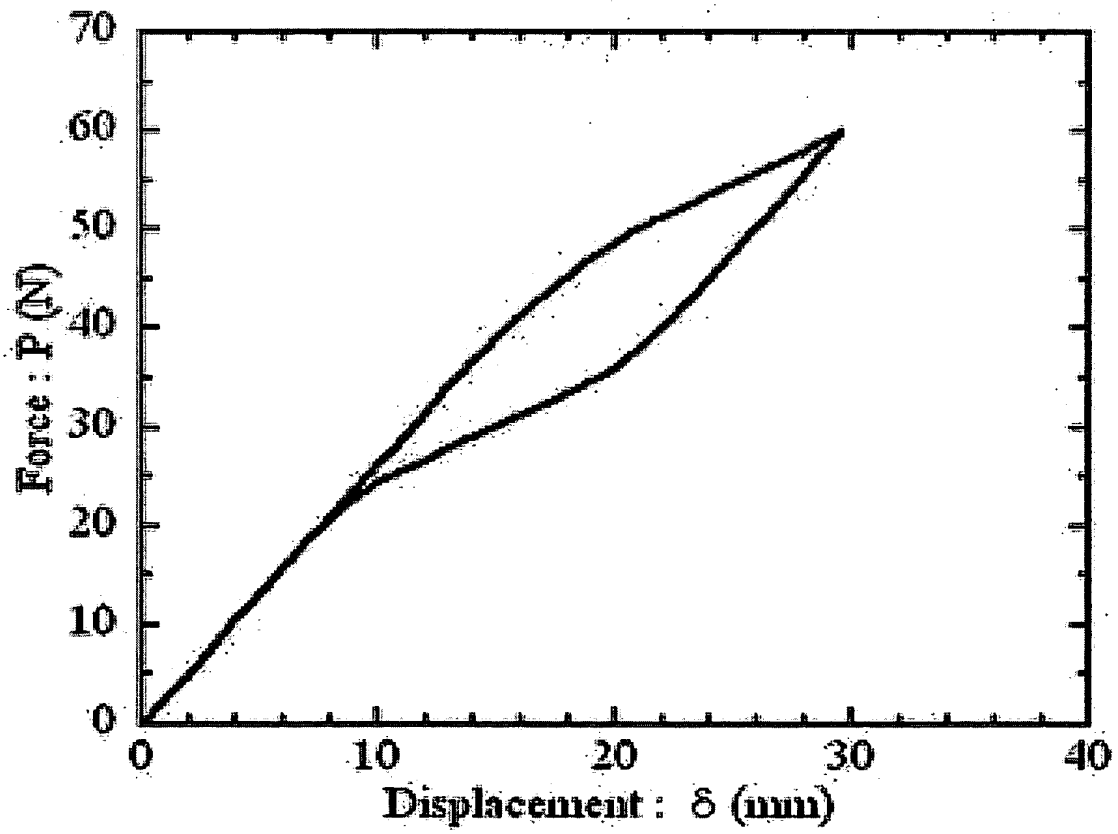
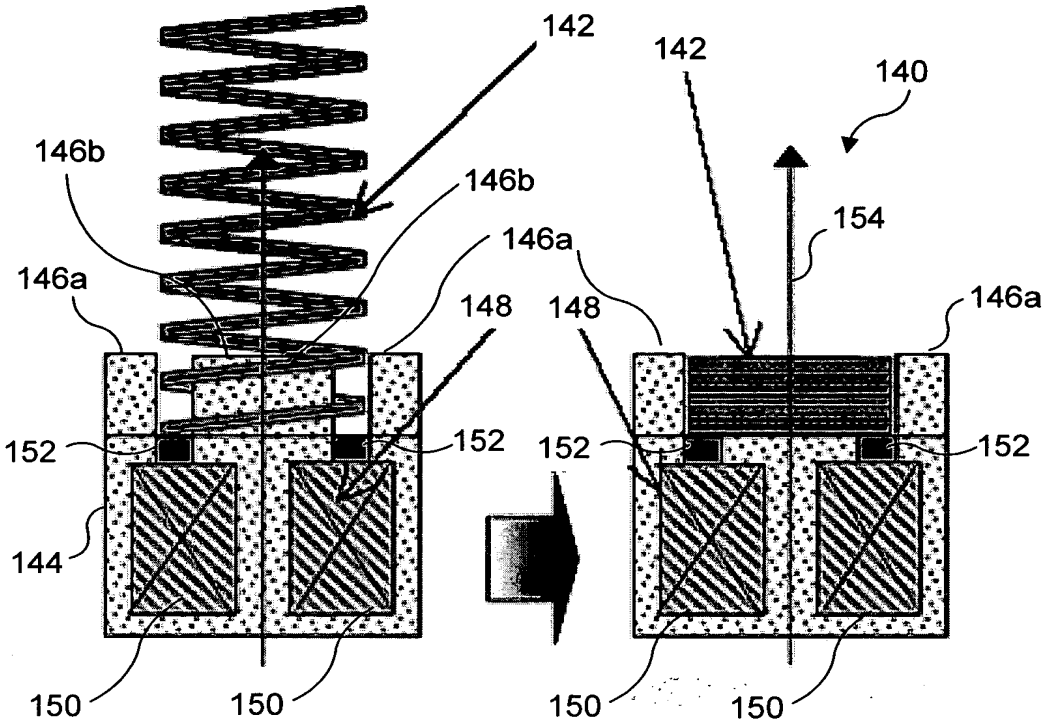

70
60
50
40
30
20
10
0
Force : P (N)
0
10
20
30
40
Displacement : δ (mm)

FIG. 6

FIG. 7


142
142
140
146b
146b
154
146a
146a
148
148
146a
152
152
152
152
144
150
150
150
150

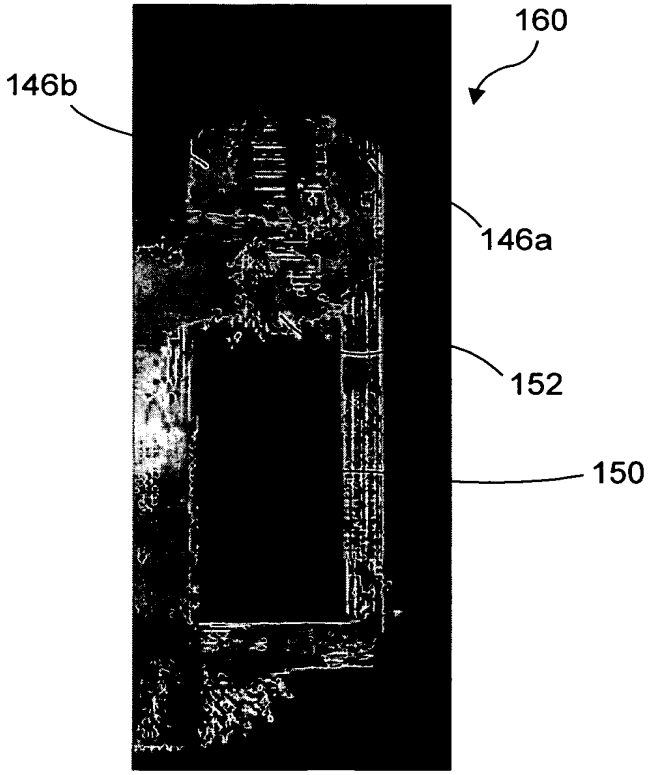

160
146b
146a
152
150

FIG. 8

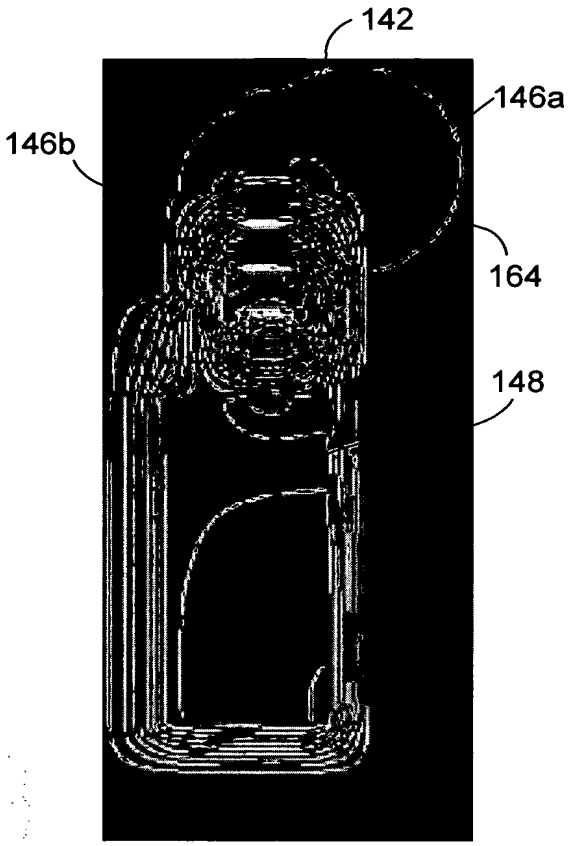


FIG. 9A

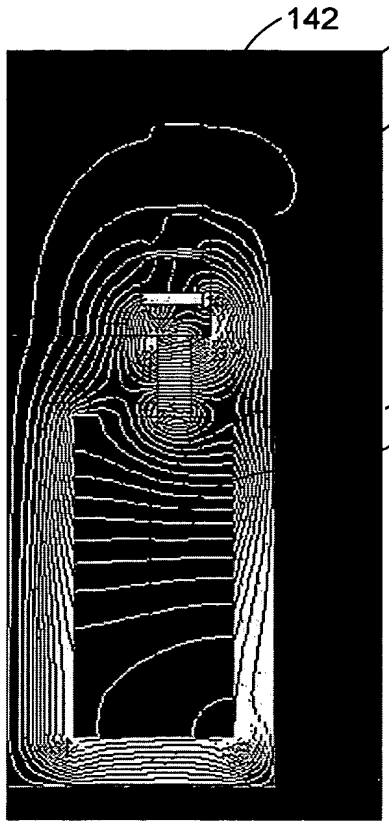


FIG. 9B

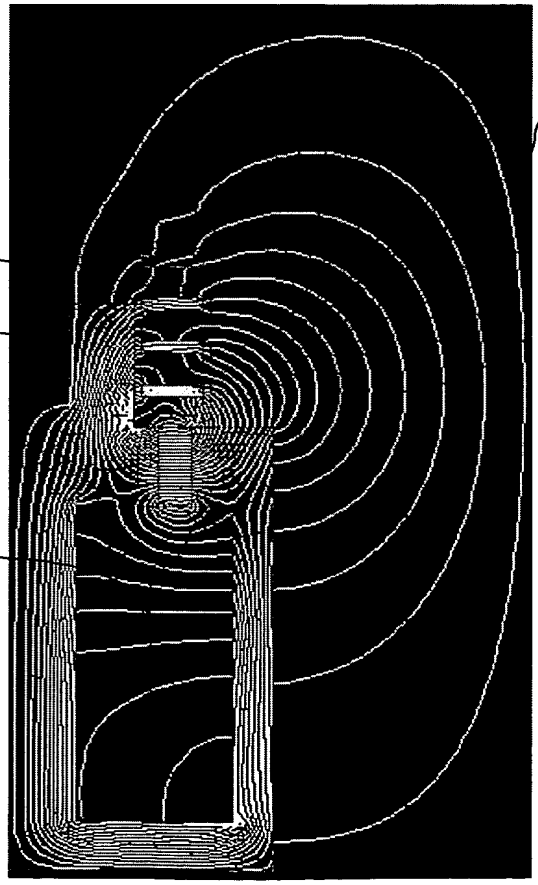


FIG. 9C

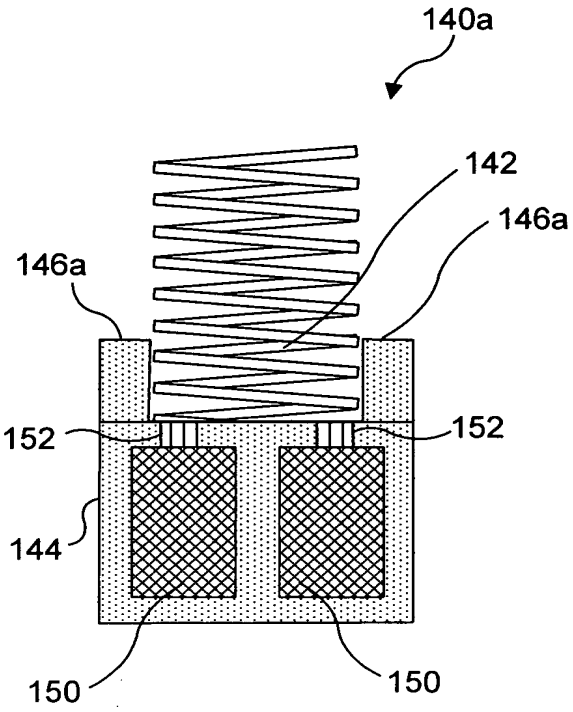


FIG. 10A

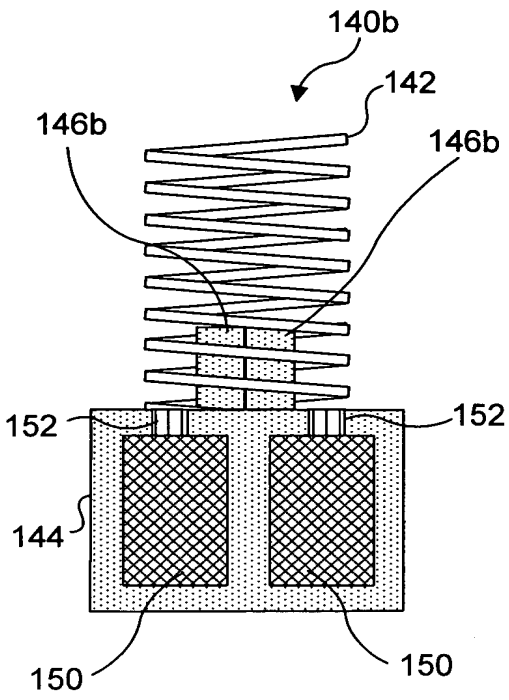


FIG. 10B

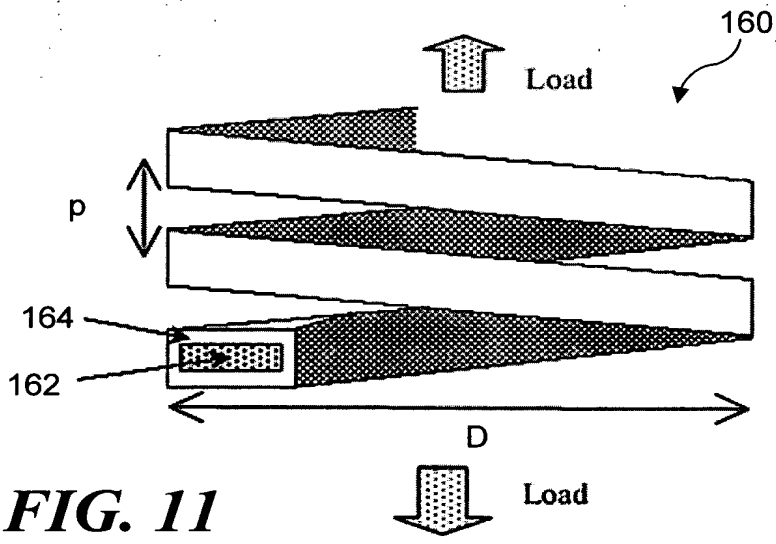


FIG. 11

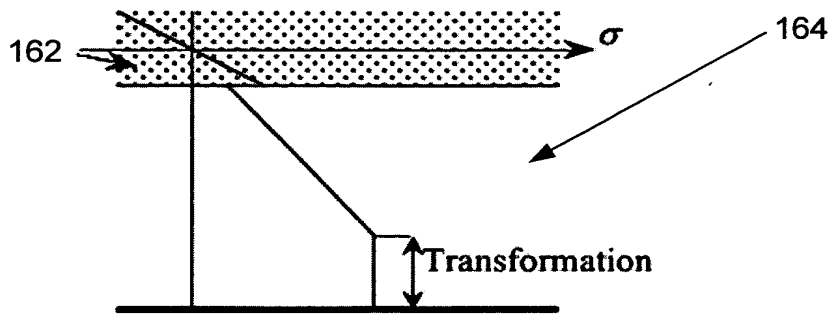


FIG. 12

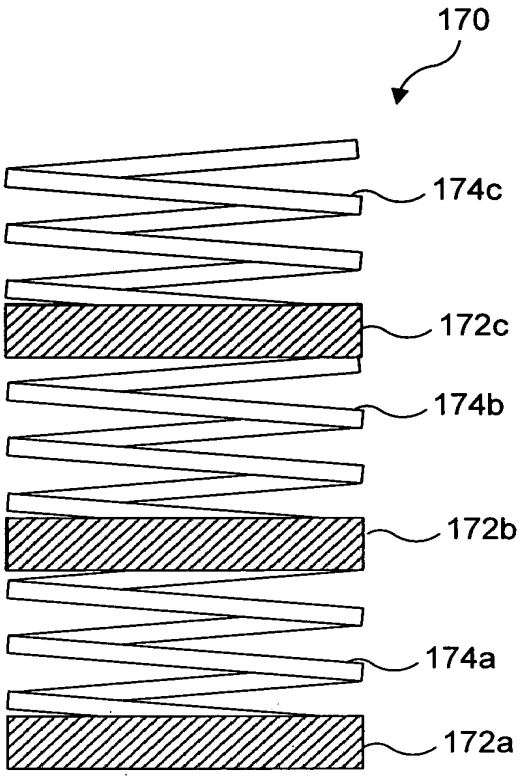


FIG. 13A

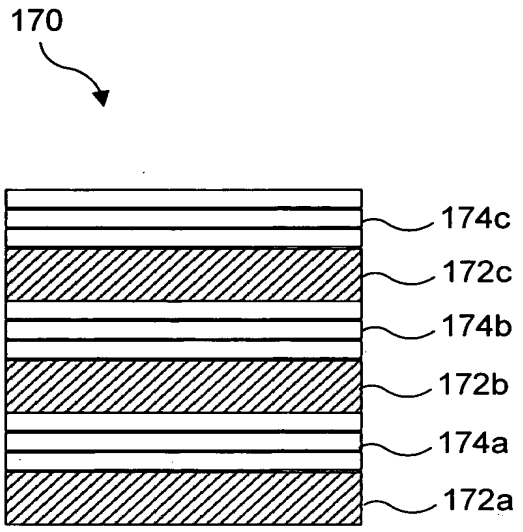


FIG. 13B

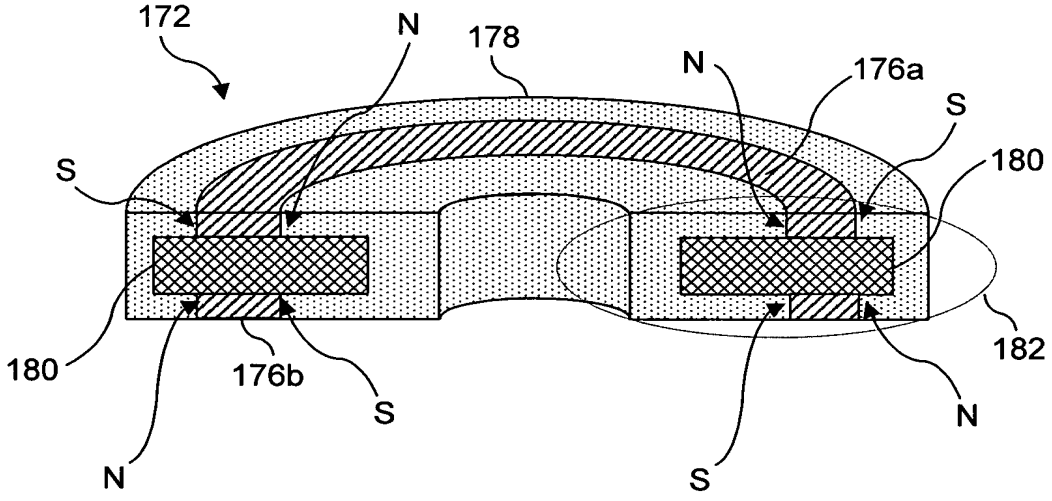


FIG. 14

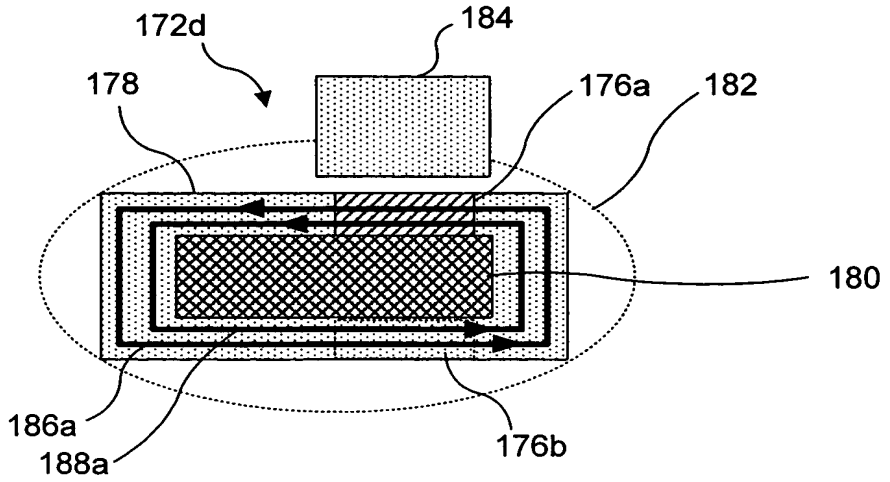


FIG. 15A

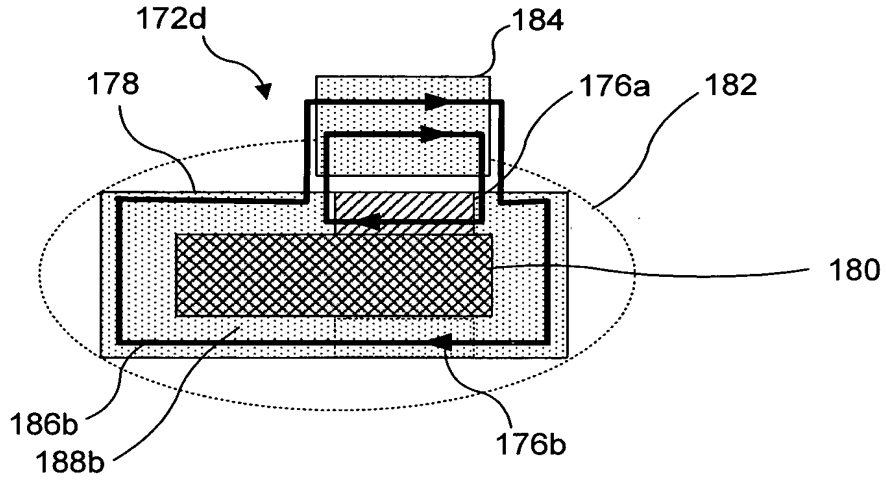


FIG. 15B

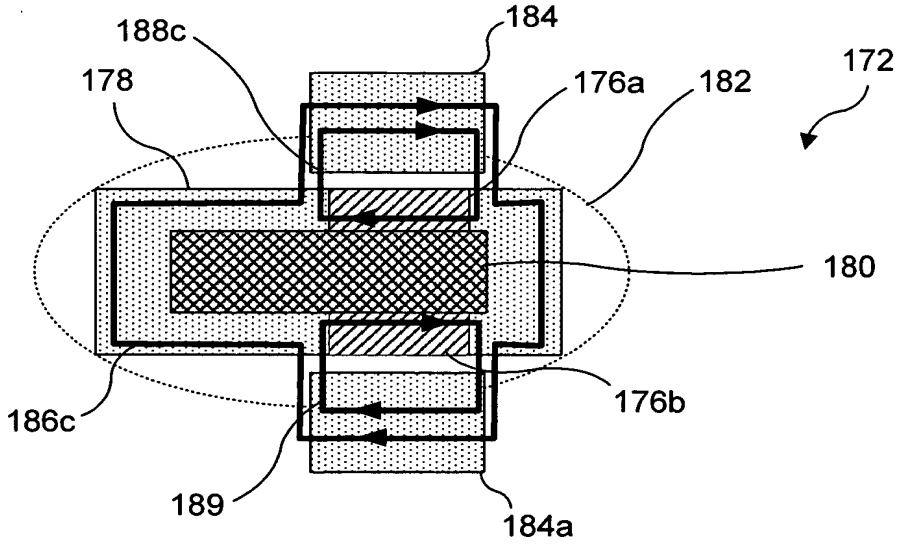


FIG. 15C

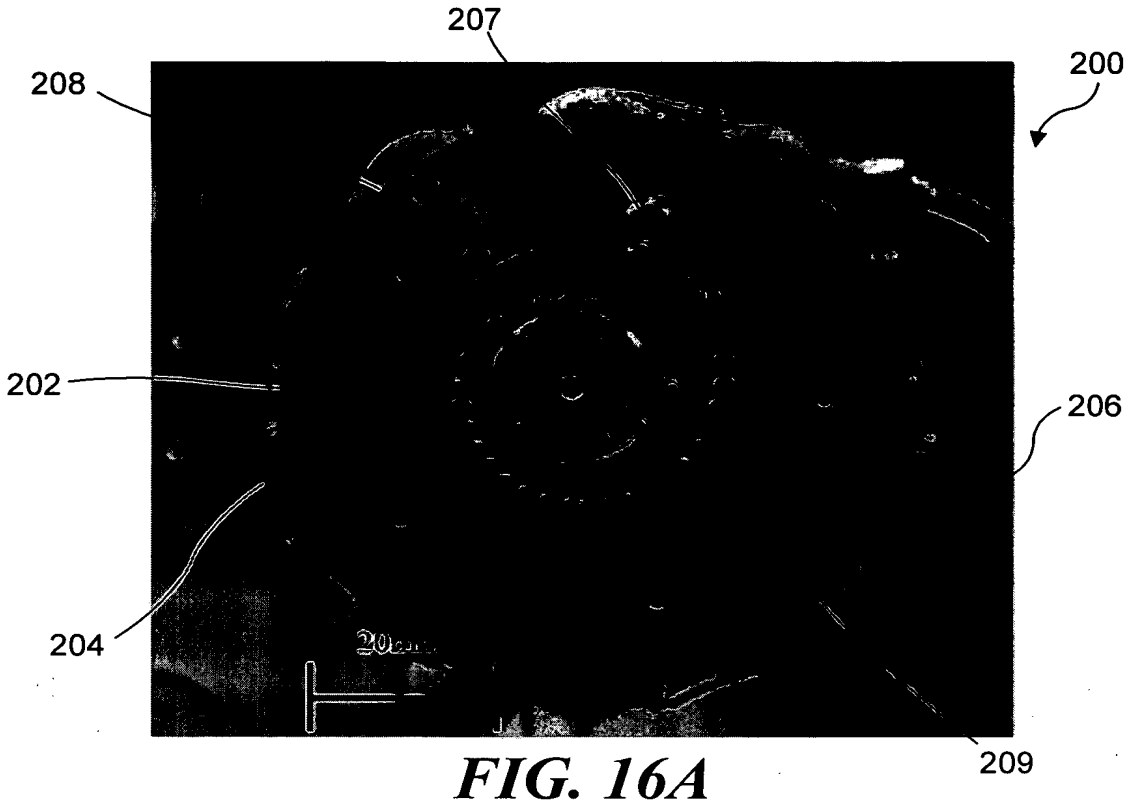


FIG. 16A

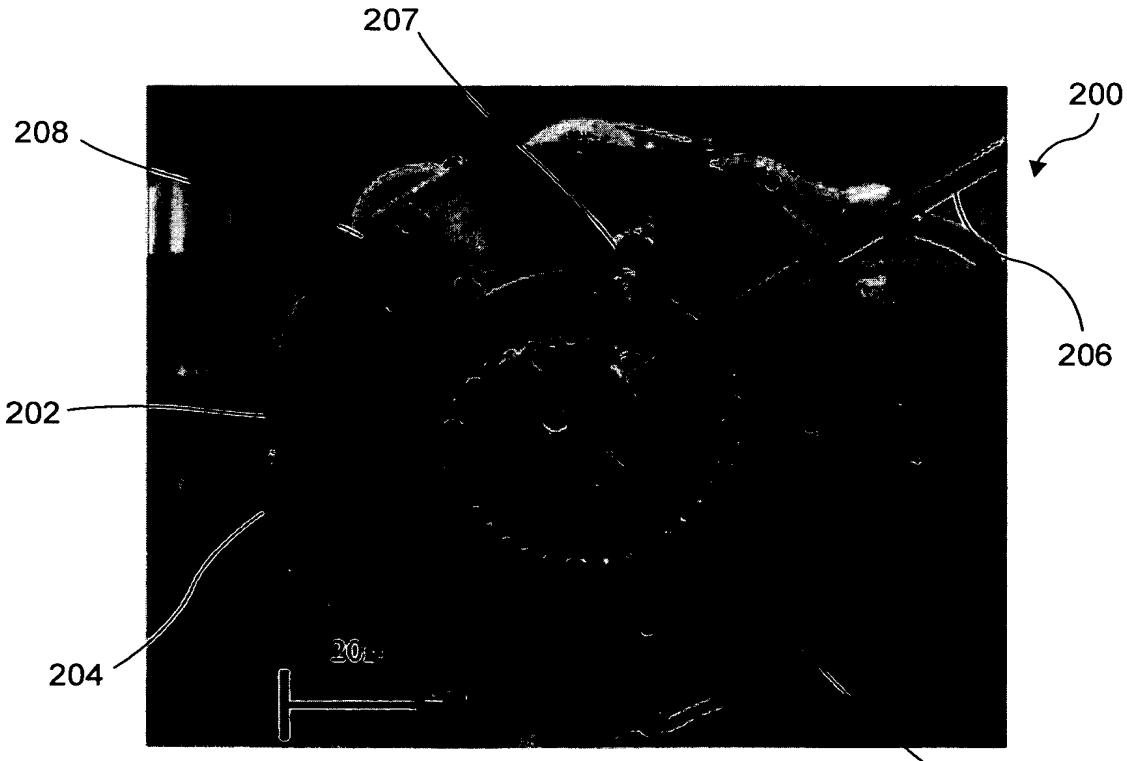


FIG. 16B

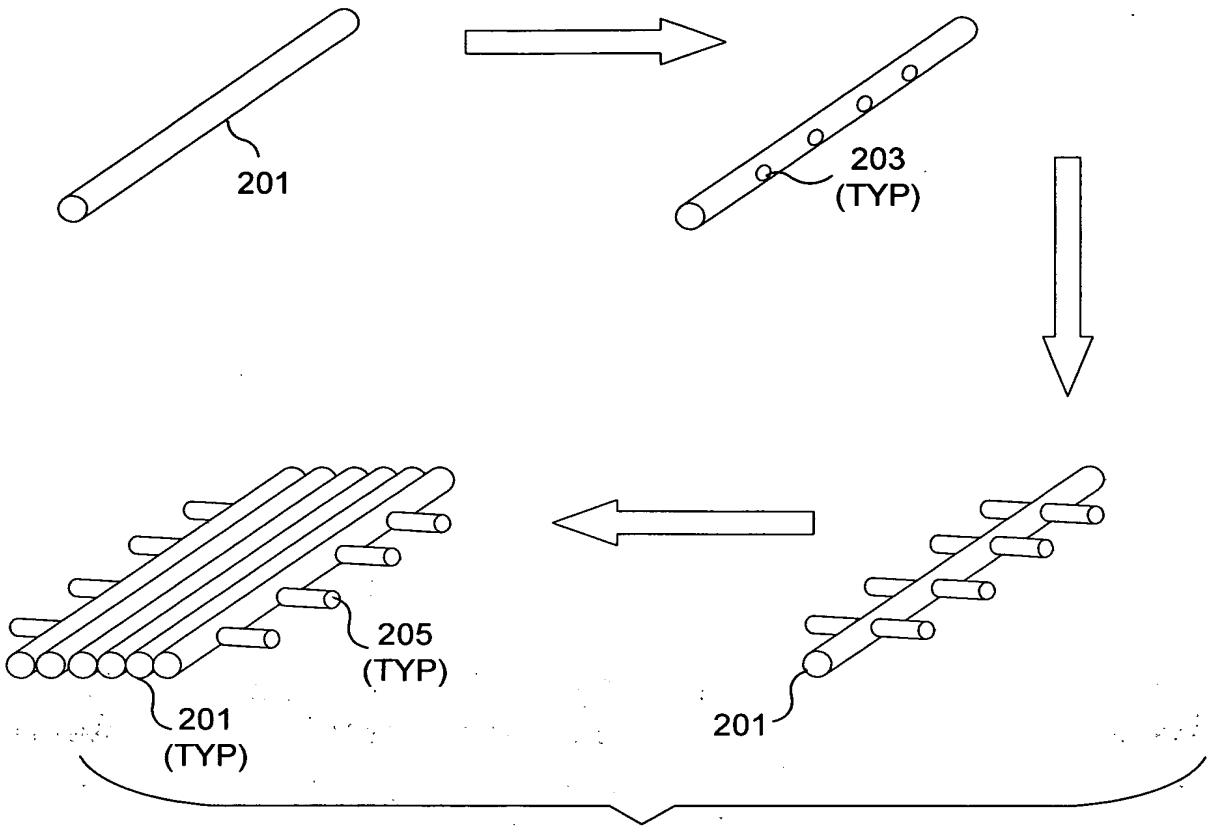


FIG. 16C

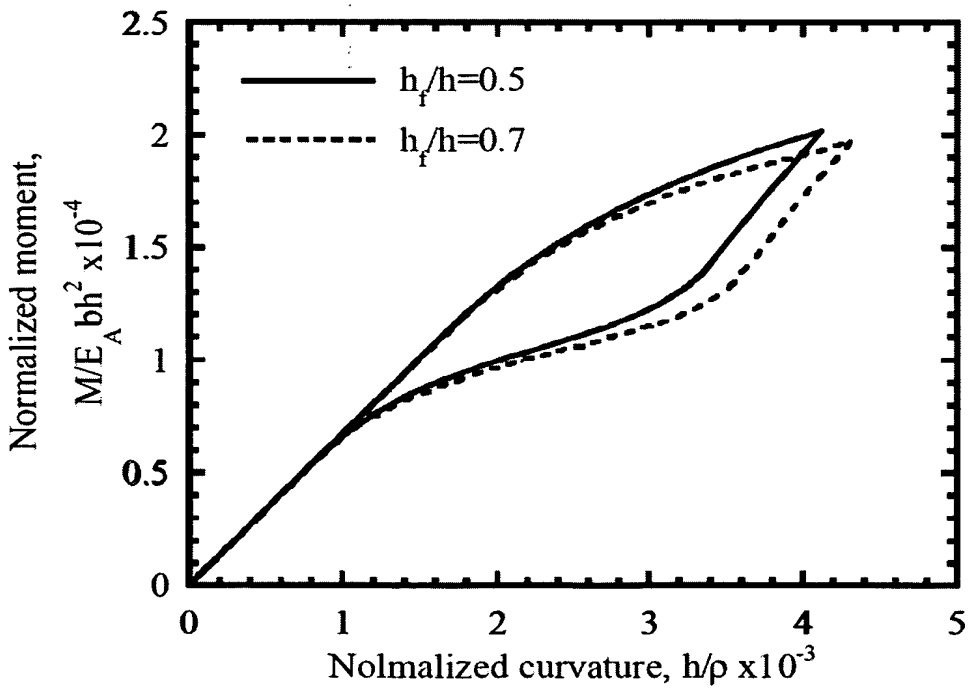


FIG. 24

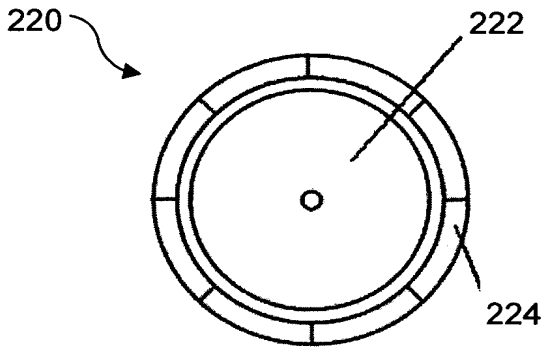


FIG. 17A
PRIOR ART

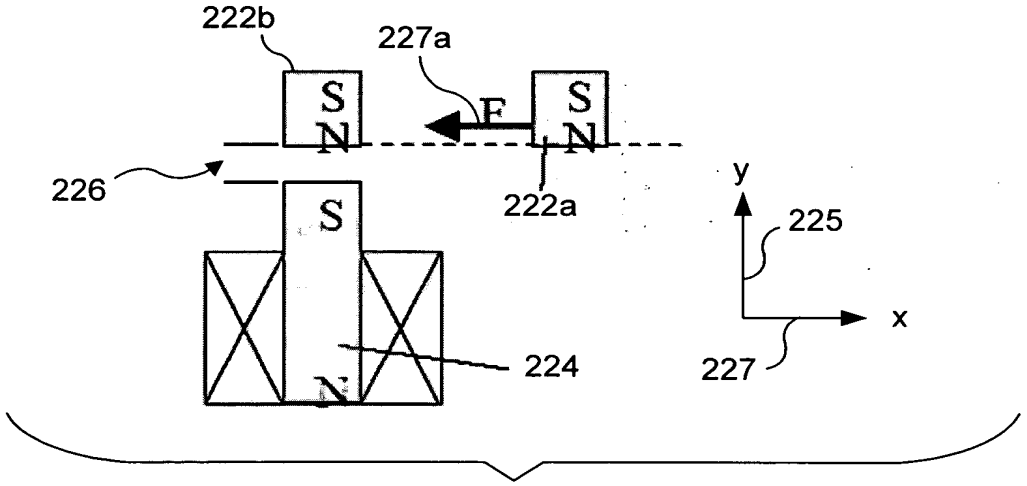


FIG. 17B PRIOR ART

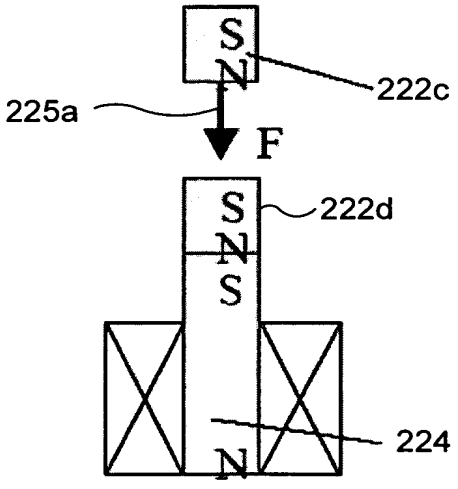


FIG. 17C

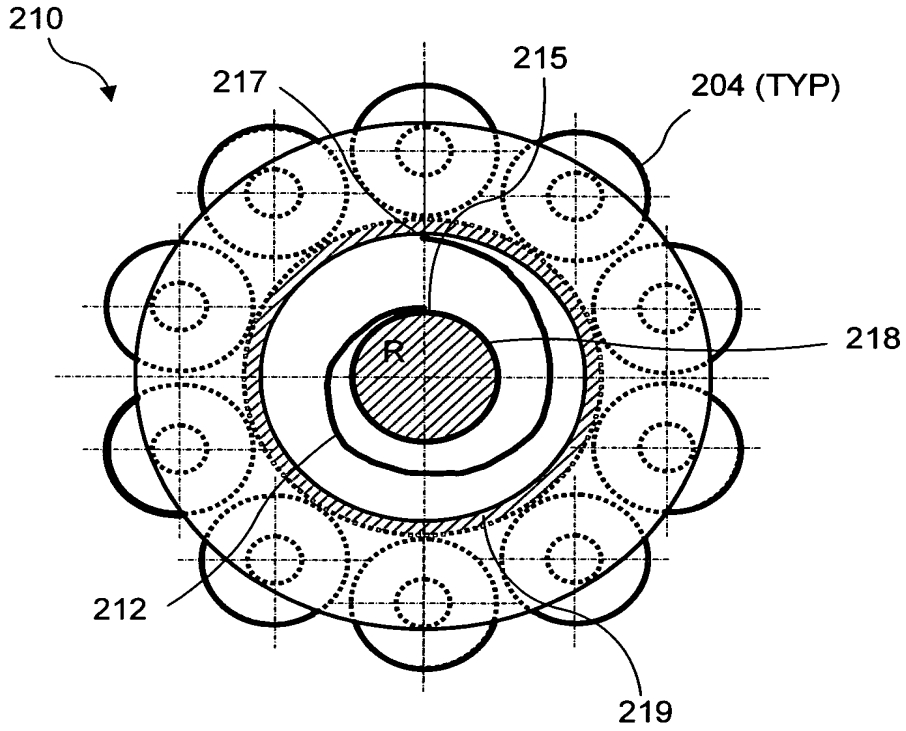


FIG. 18A

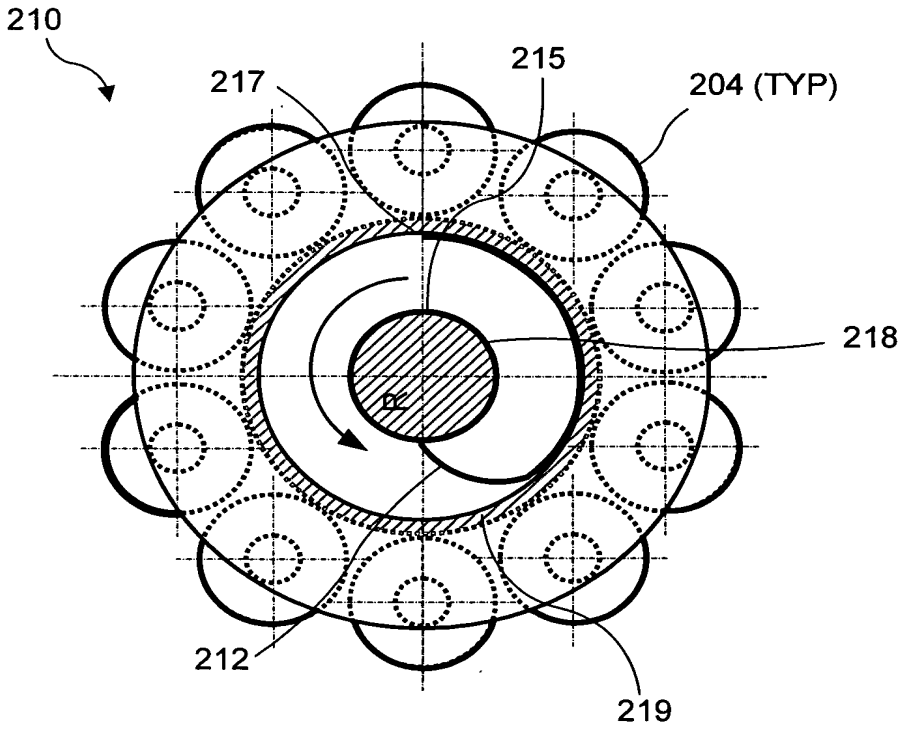


FIG. 18B

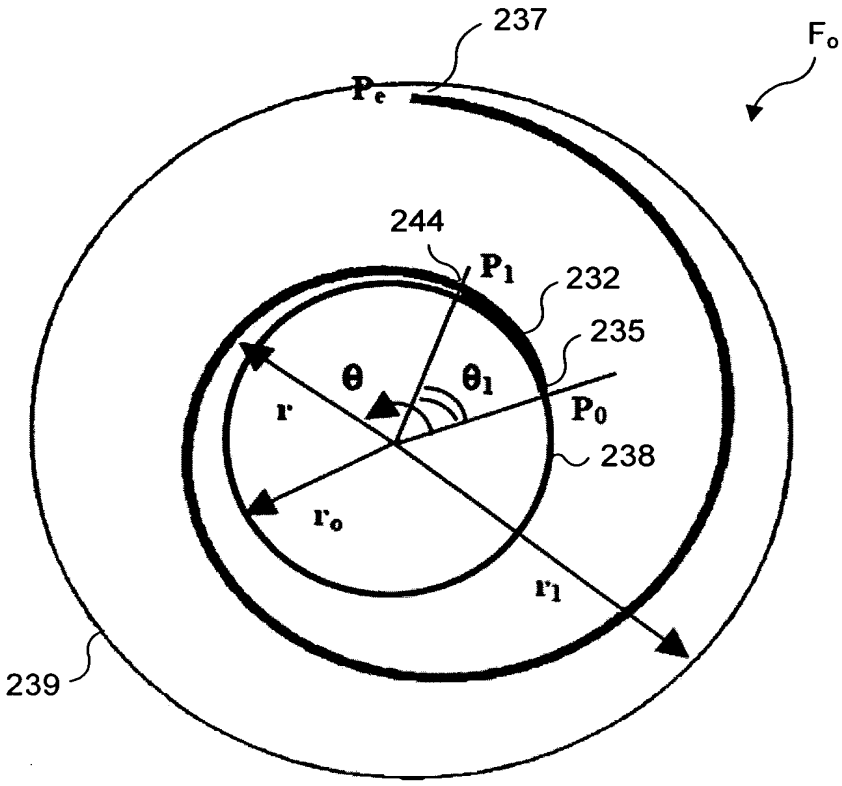


FIG. 19A

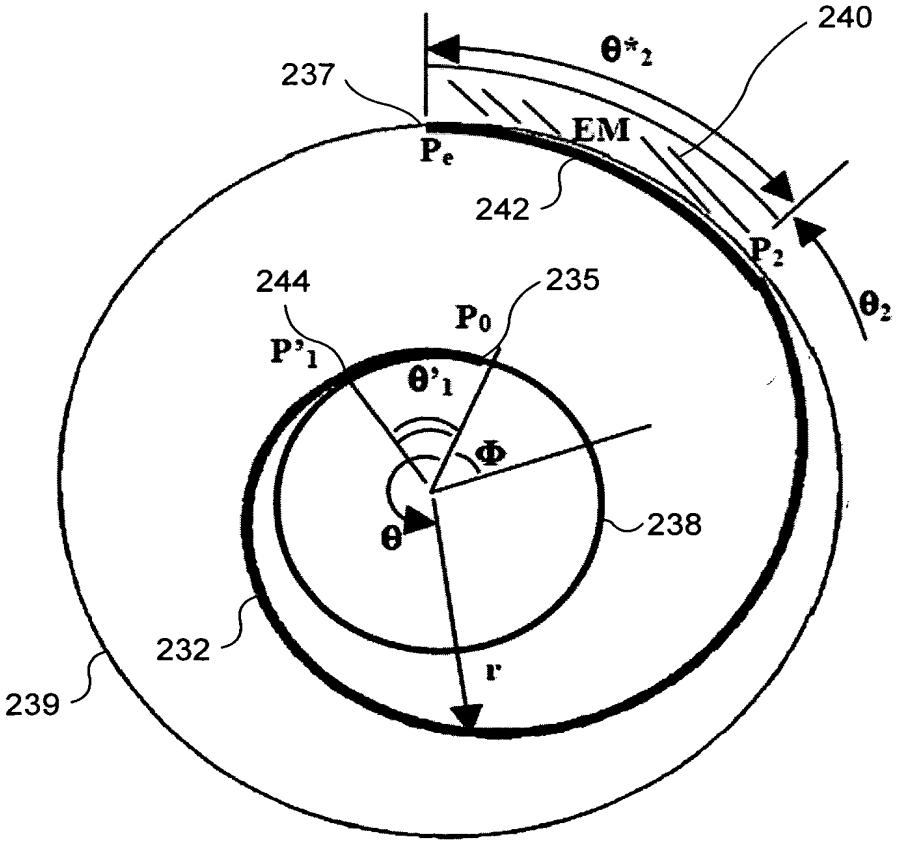


FIG. 19B

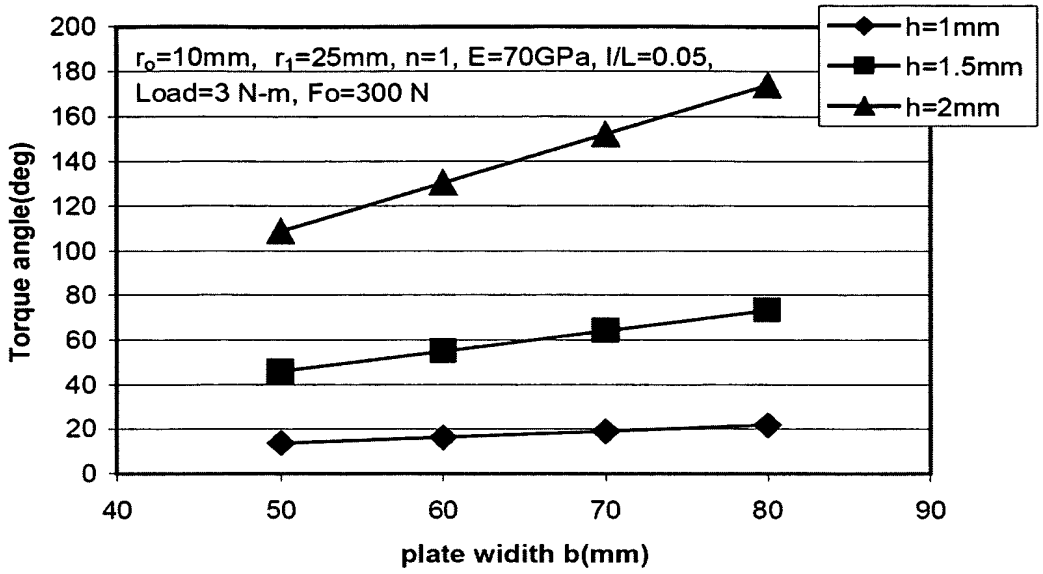

r_o=10mm, r_1=25mm, n=1, E=70GPa, I/L=0.05,
Load=3 N-m, Fo=300 N
h=1mm
h=1.5mm
h=2mm
Torque angle(deg)
200
180
160
140
120
100
80
60
40
20
0
40
50
60
70
80
90
plate widith b(mm)

FIG. 20

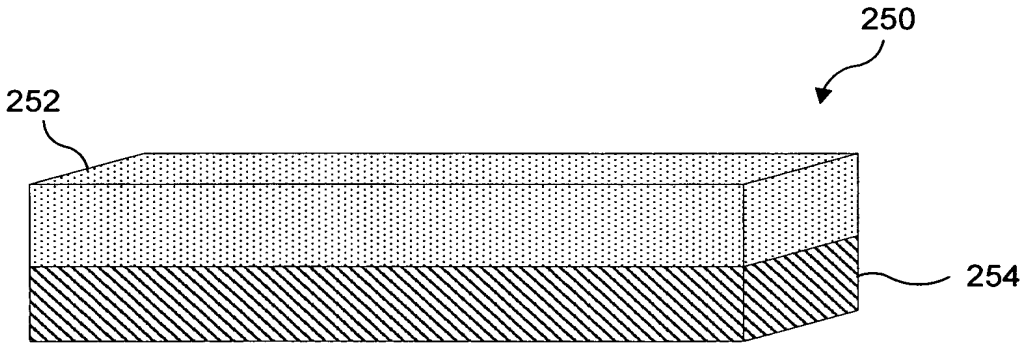

250
252
254

FIG. 21

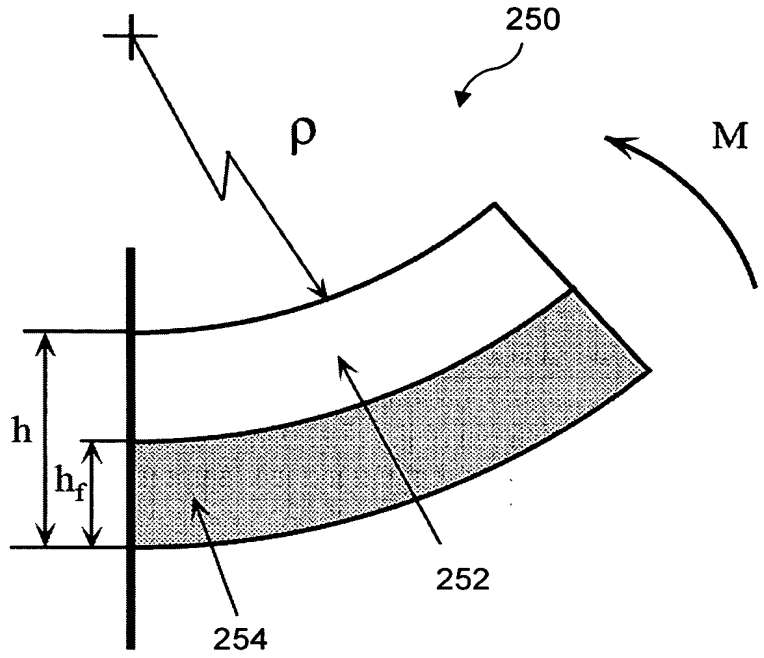

250
ρ
M
h
h_f
252
254

FIG. 22

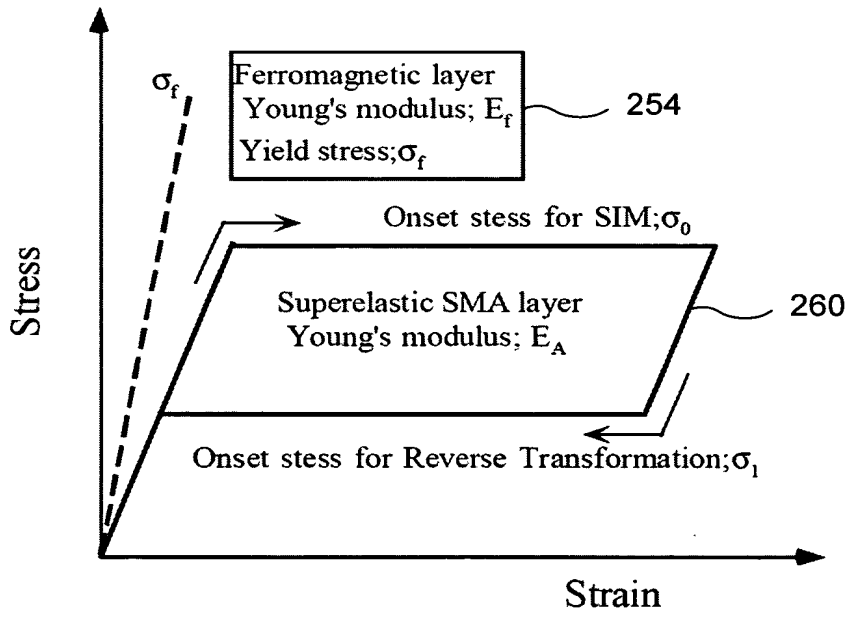

σ_f
Ferromagnetic layer
Young's modulus; E_f
Yield stress;σ_f
254
Onset stess for SIM;σ_0
Superelastic SMA layer
Young's modulus; E_A
260
Onset stess for Reverse Transformation;σ_1
Stress
Strain

FIG. 23

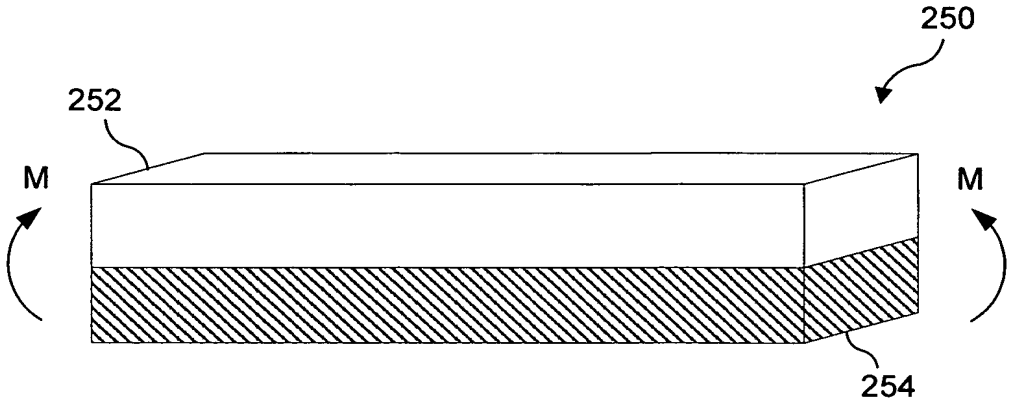


FIG. 25A

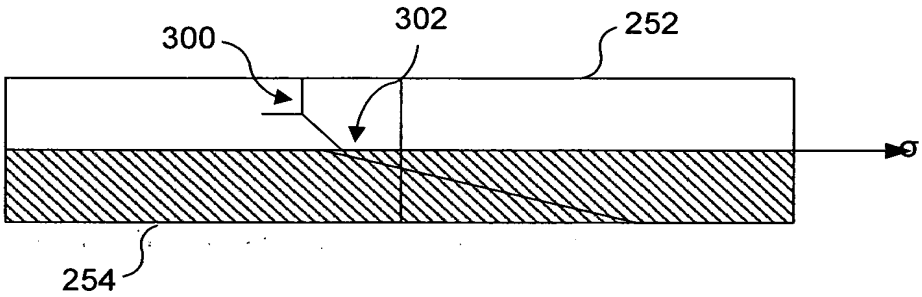


FIG. 25B

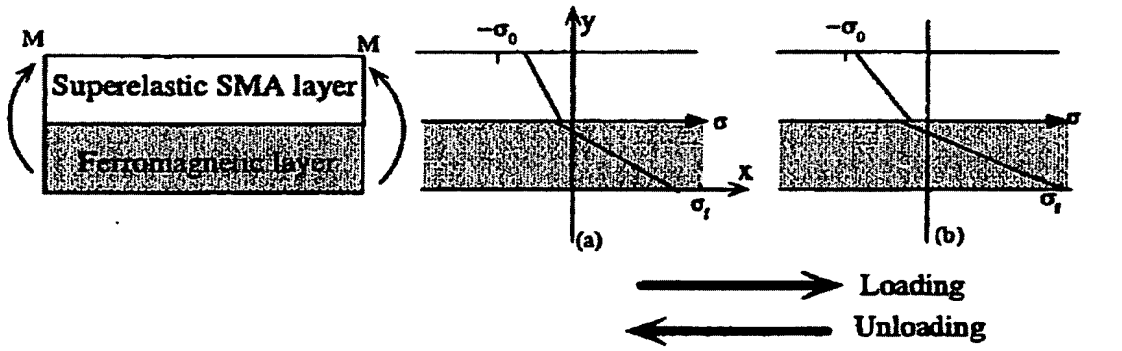


FIG. 26A

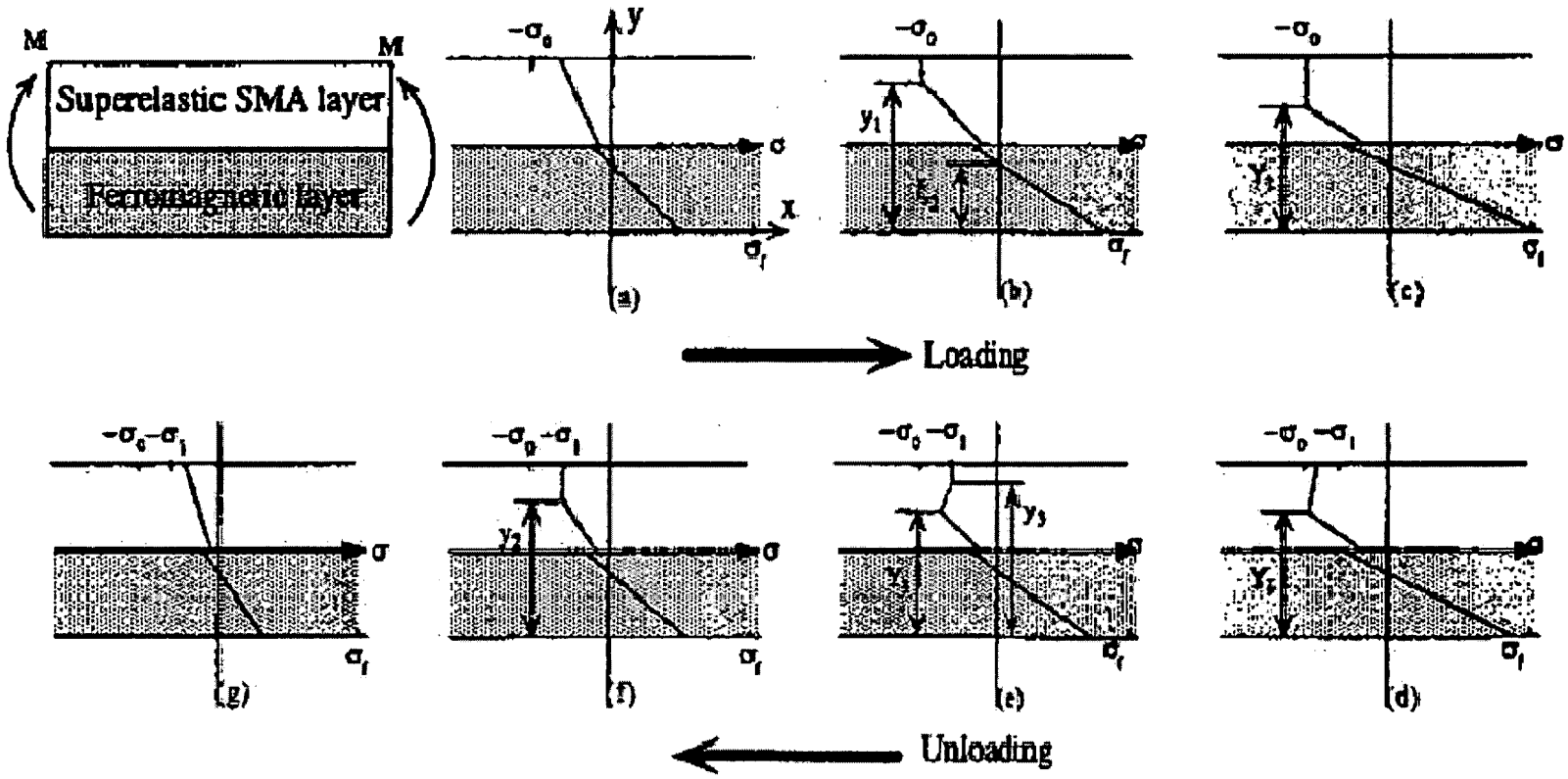

M
M
Superelastic SMA layer
Ferromagnetic layer
y
x
σ
(a)
(b)
(c)
Loading
(g)
(f)
(e)
(d)
Unloading

FIG. 26B

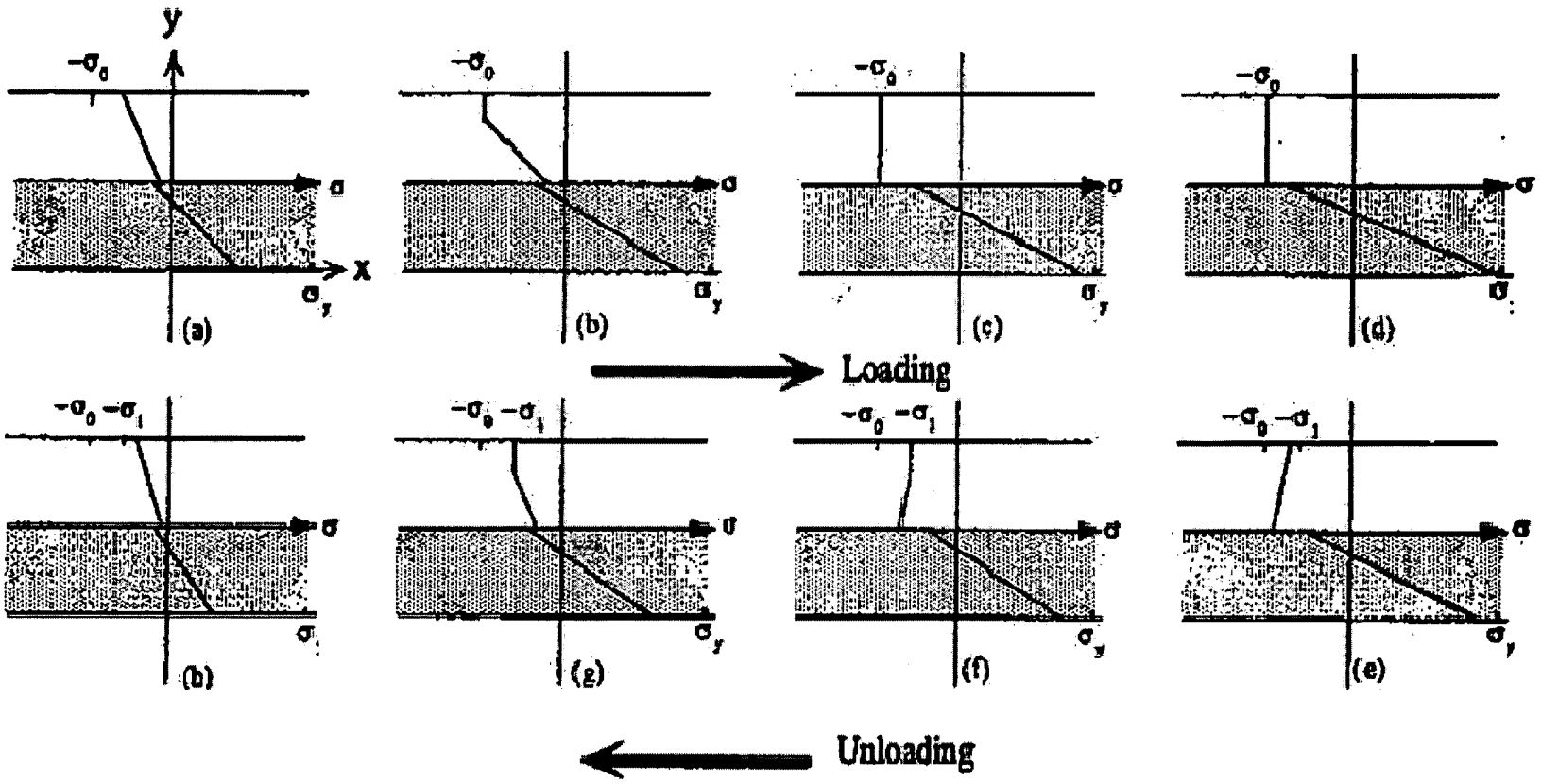

y
x
$-\sigma_0$
σ
σ_y
(a)
(b)
(c)
(d)
Loading
$-\sigma_0 - \sigma_1$
(b)
(g)
(f)
(e)
Unloading

FIG. 26C

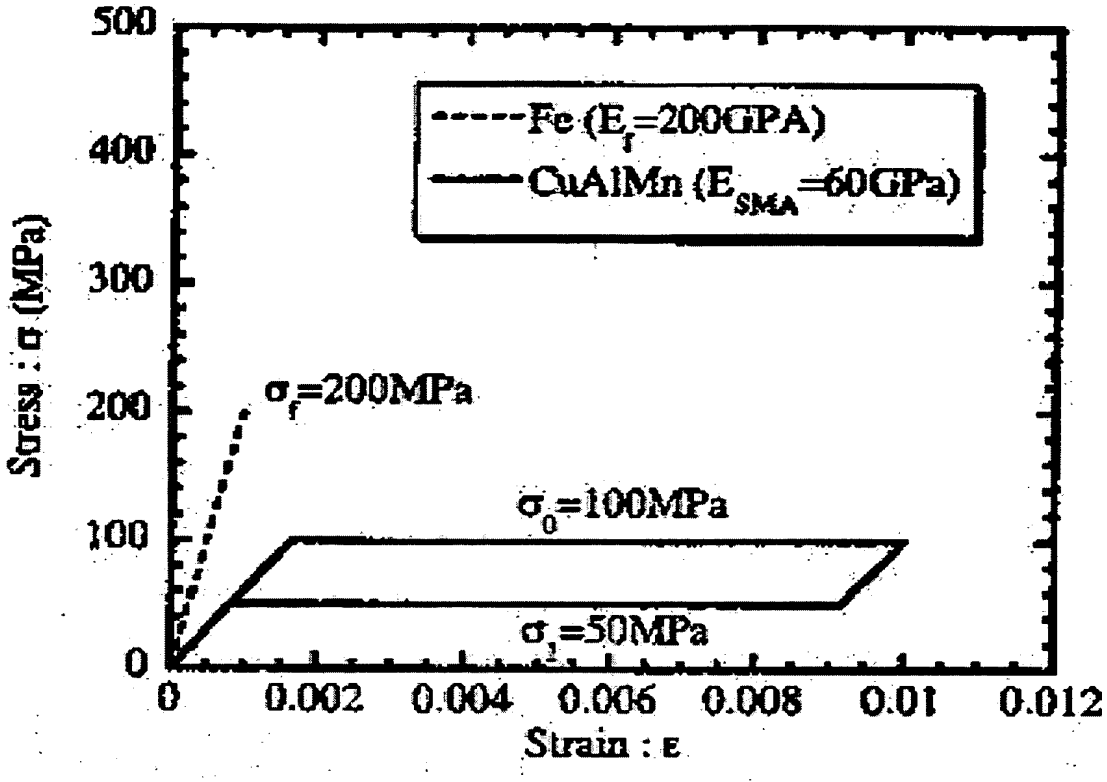

500
400
300
200
100
0
Stress : σ (MPa)
Fe (E_f=200GPA)
CuAlMn (E_{SMA}=60GPa)
σ_f=200MPa
σ_0=100MPa
σ_1=50MPa
0
0.002
0.004
0.006
0.008
0.01
0.012
Strain : ε

FIG. 27

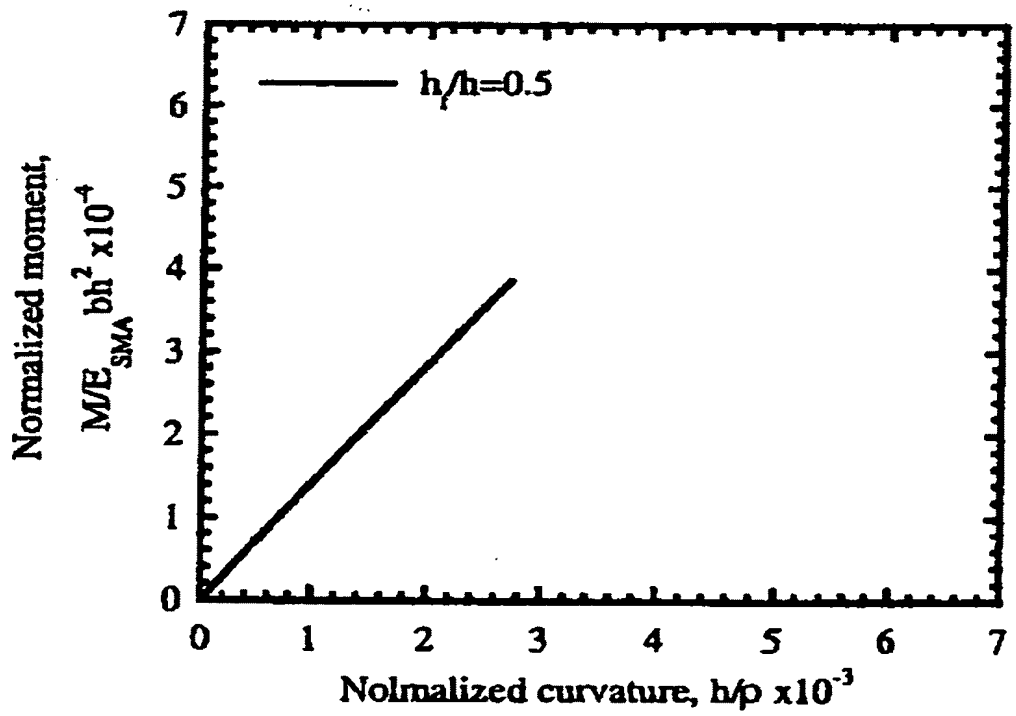

7
6
5
4
3
2
1
0
Normalized moment,
$M/E_{SMA}bh^2 x10^{-4}$
h_f/h=0.5
0
1
2
3
4
5
6
7
Nolmalized curvature, h/ρ $x10^{-3}$

FIG. 28

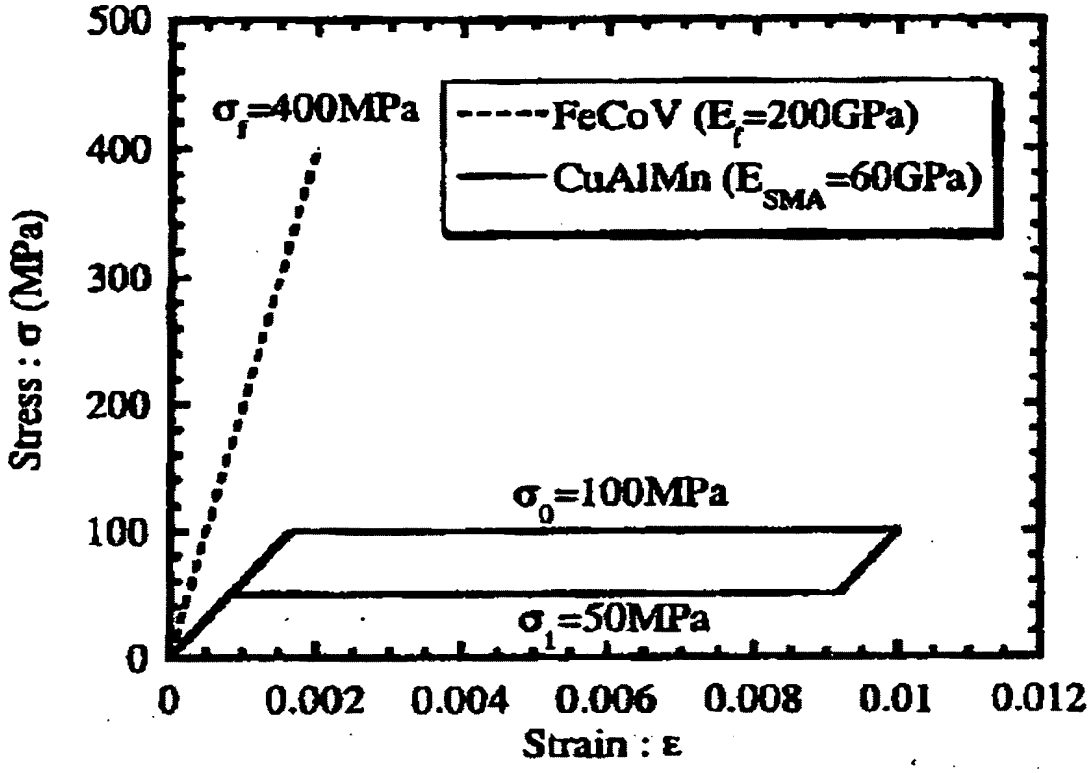

500
400
300
200
100
0
Stress : σ (MPa)
σf=400MPa
-----FeCoV (Ef=200GPa)
——CuAlMn (ESMA=60GPa)
σ0=100MPa
σ1=50MPa
0
0.002
0.004
0.006
0.008
0.01
0.012
Strain : ε

FIG. 29

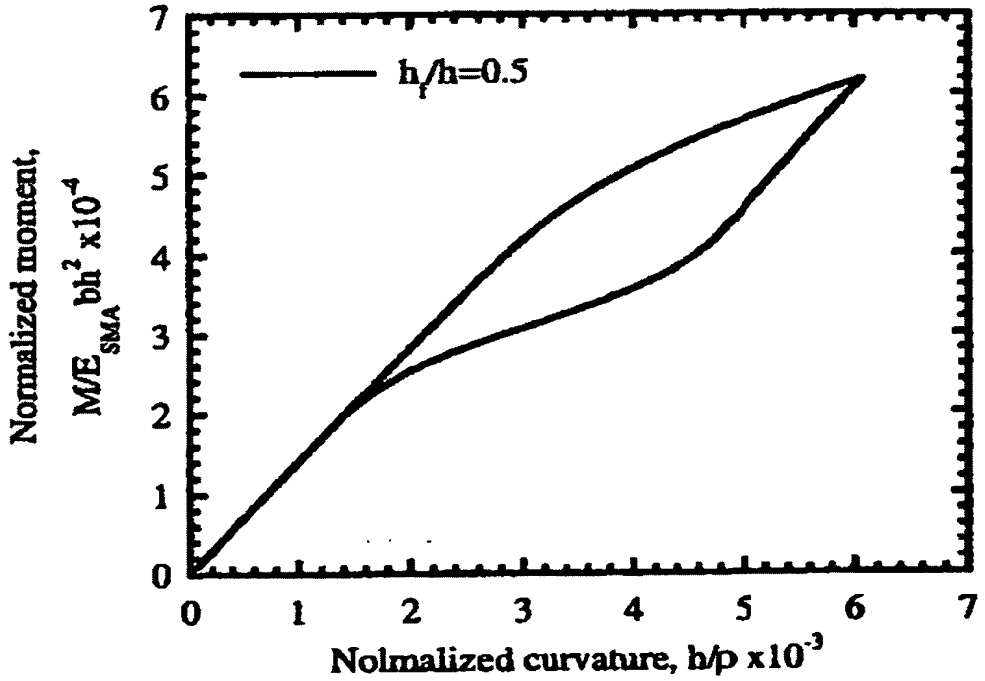

7
6
5
4
3
2
1
0
Normalized moment, M/ESMA bh2 x10-4
hf/h=0.5
0
1
2
3
4
5
6
7
Nolmalized curvature, h/ρ x10-3

FIG. 30

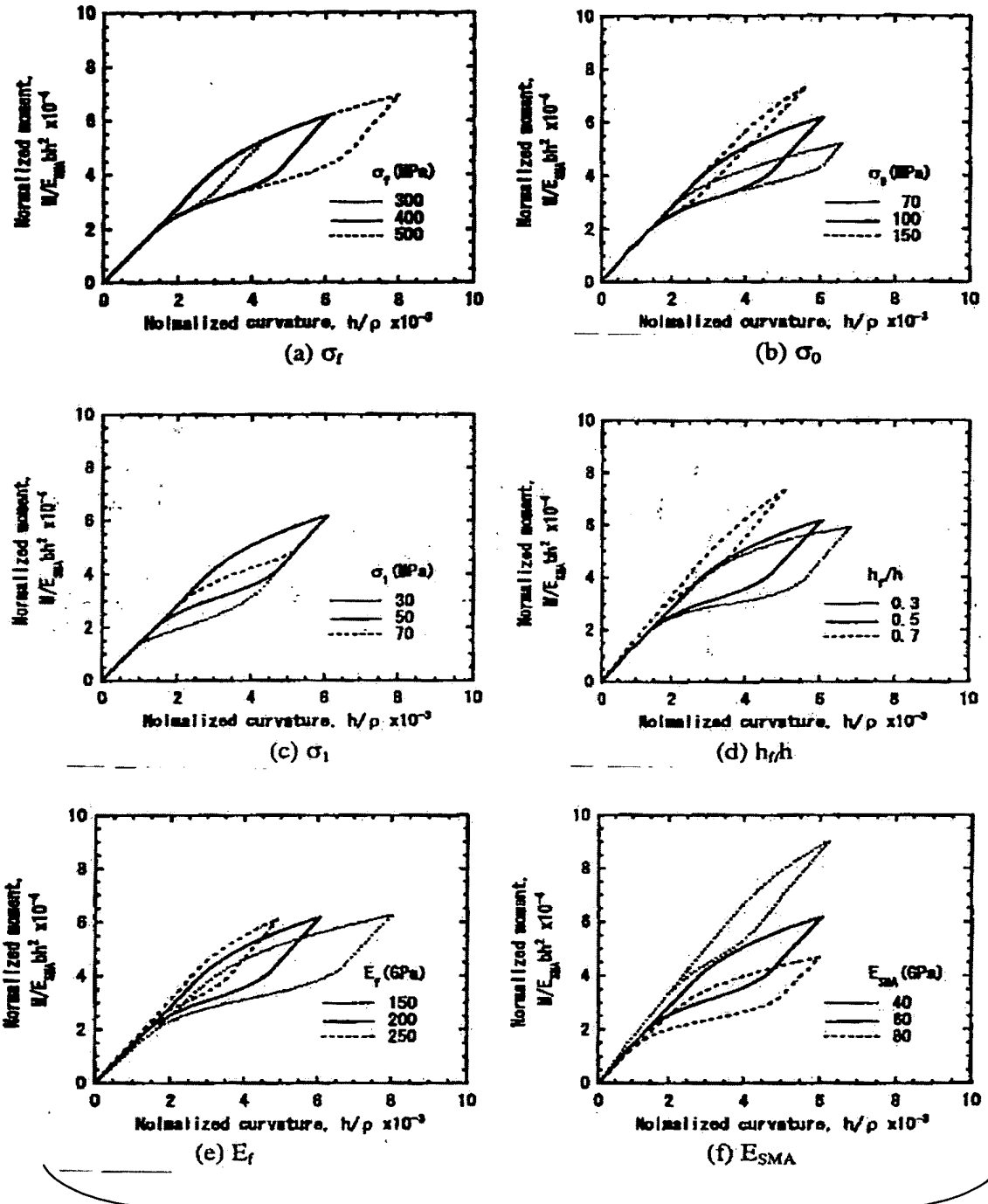
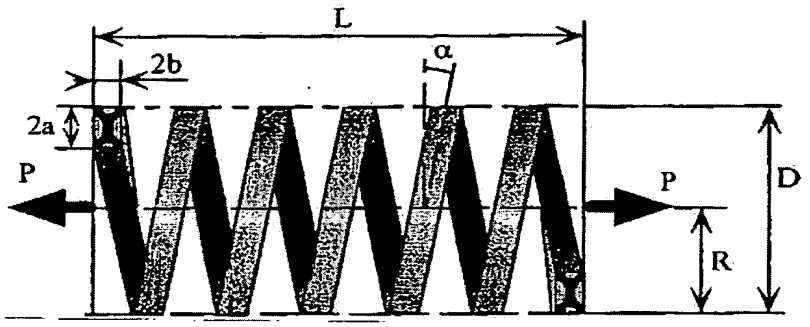

Normalized moment, M/E_SMA bh² x10⁻⁴
Normalized curvature, h/ρ x10⁻³
σ_f (MPa)
300
400
500
(a) σ_f
σ_0 (MPa)
70
100
150
(b) σ_0
σ_1 (MPa)
30
50
70
(c) σ_1
h_f/h
0.3
0.5
0.7
(d) h_f/h
E_f (GPa)
150
200
250
(e) E_f
E_SMA (GPa)
40
60
80
(f) E_SMA

FIG. 31



D: the diameter of spring (D=2R)
d: the diameter of wire
p: the pitch of one cycle
n: the number of turns
L: the length of spring without load (L=np)
α: the inclined angle of the wire to the x-y plane

FIG. 32

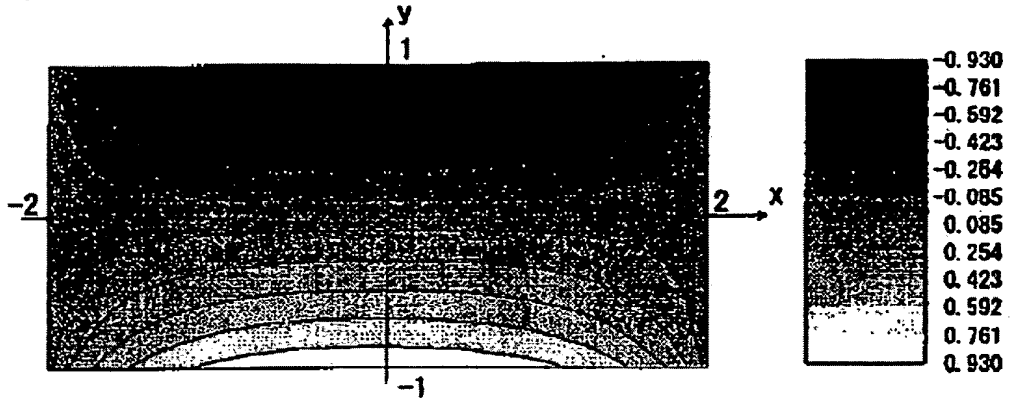


FIG. 33A

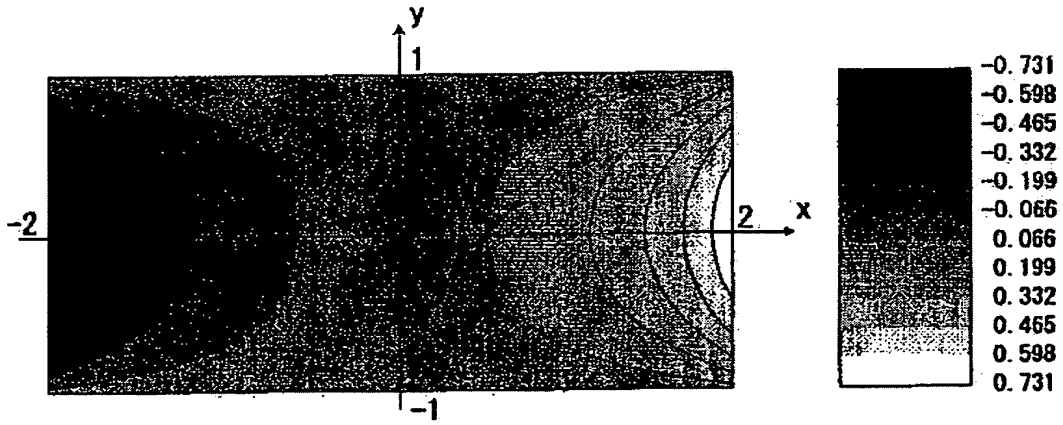


FIG. 33B

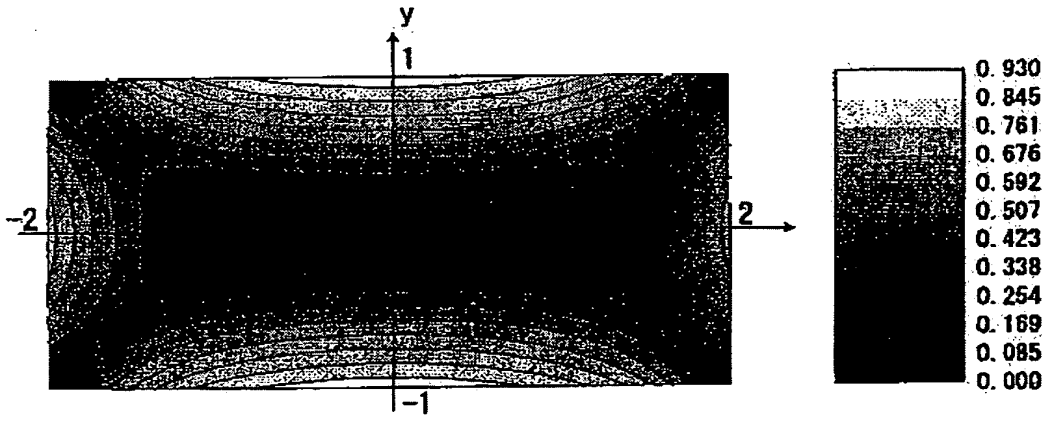


FIG. 33C

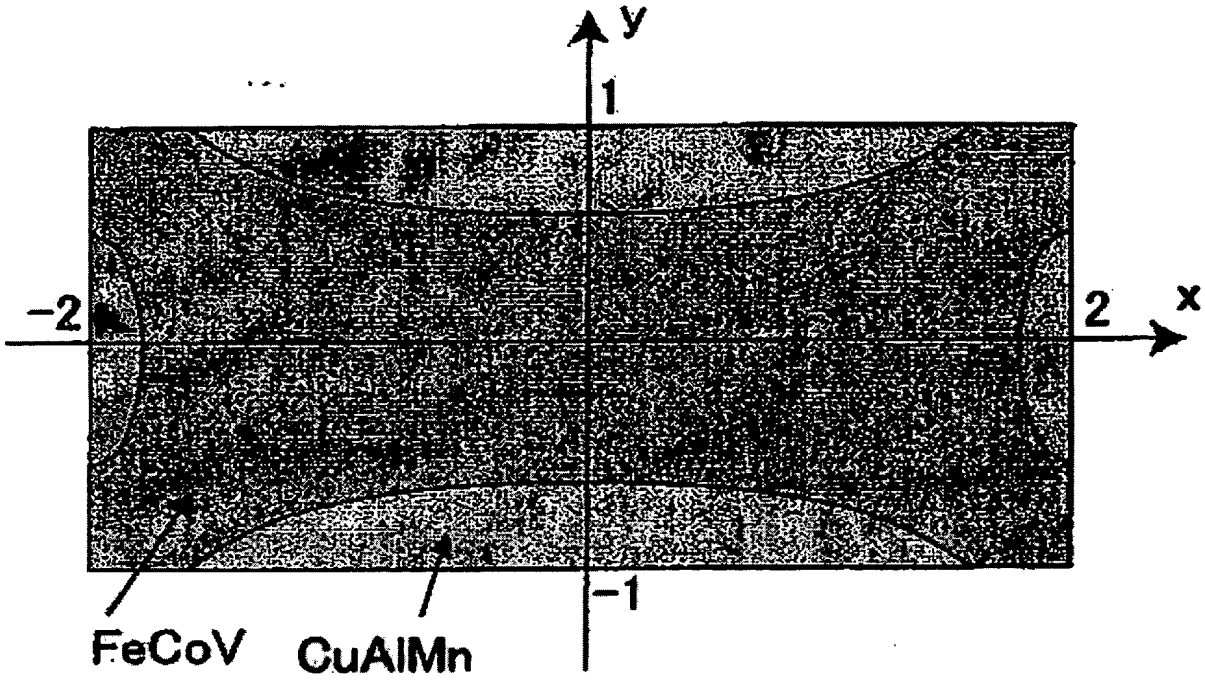

y
1
-2
2
x
-1
FeCoV
CuAlMn

FIG. 34

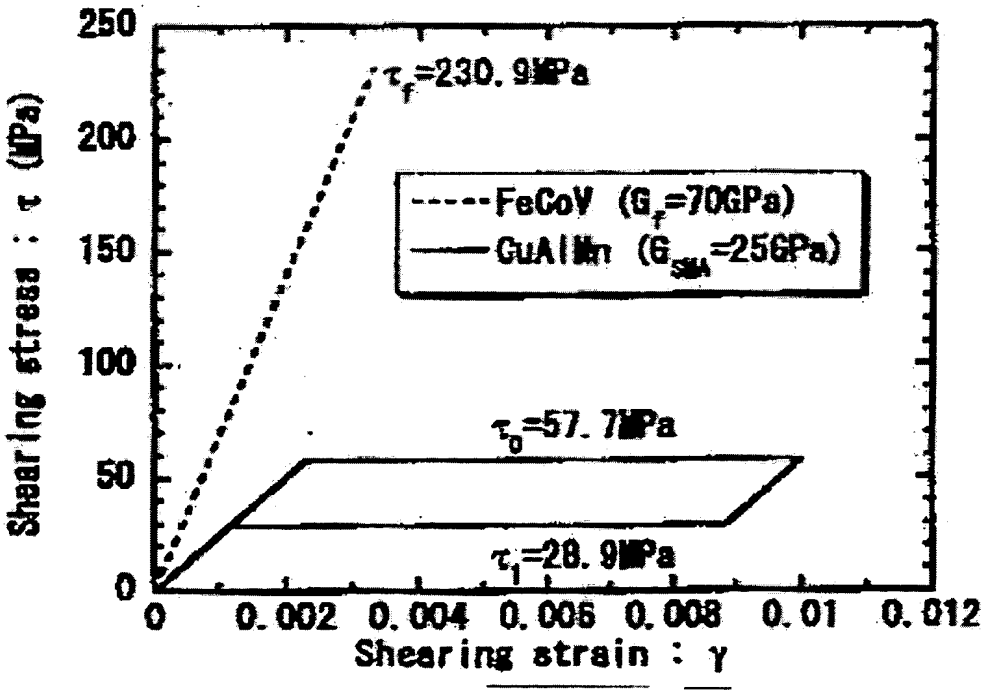

250
200
150
100
50
0
Shearing stress : τ (MPa)
τf=230.9MPa
FeCoV (Gf=70GPa)
CuAlMn (GSMA=25GPa)
τ0=57.7MPa
τ1=28.9MPa
0
0.002
0.004
0.006
0.008
0.01
0.012
Shearing strain : γ

FIG. 35

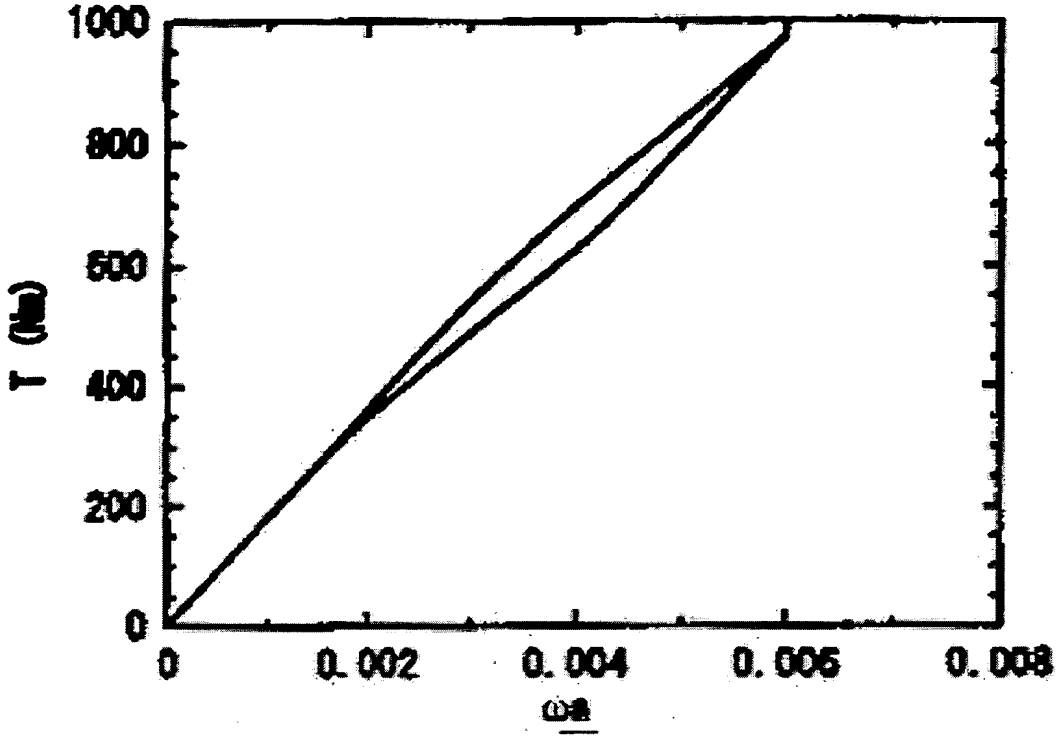


FIG. 36A

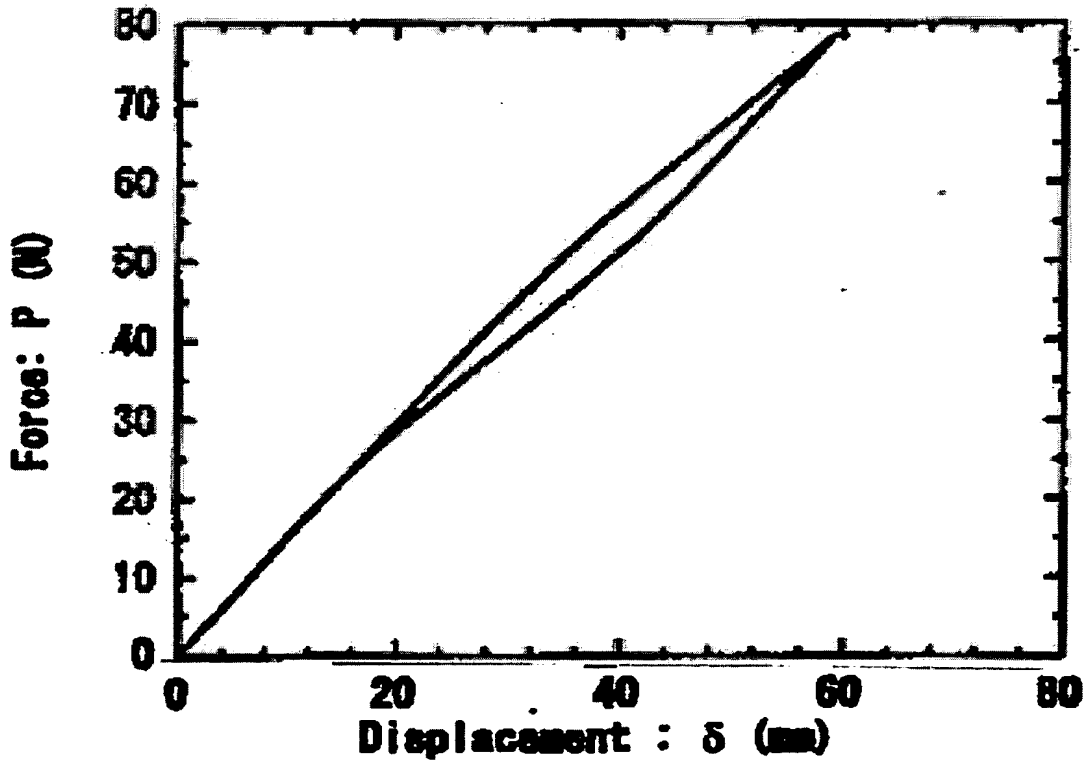


FIG. 36B

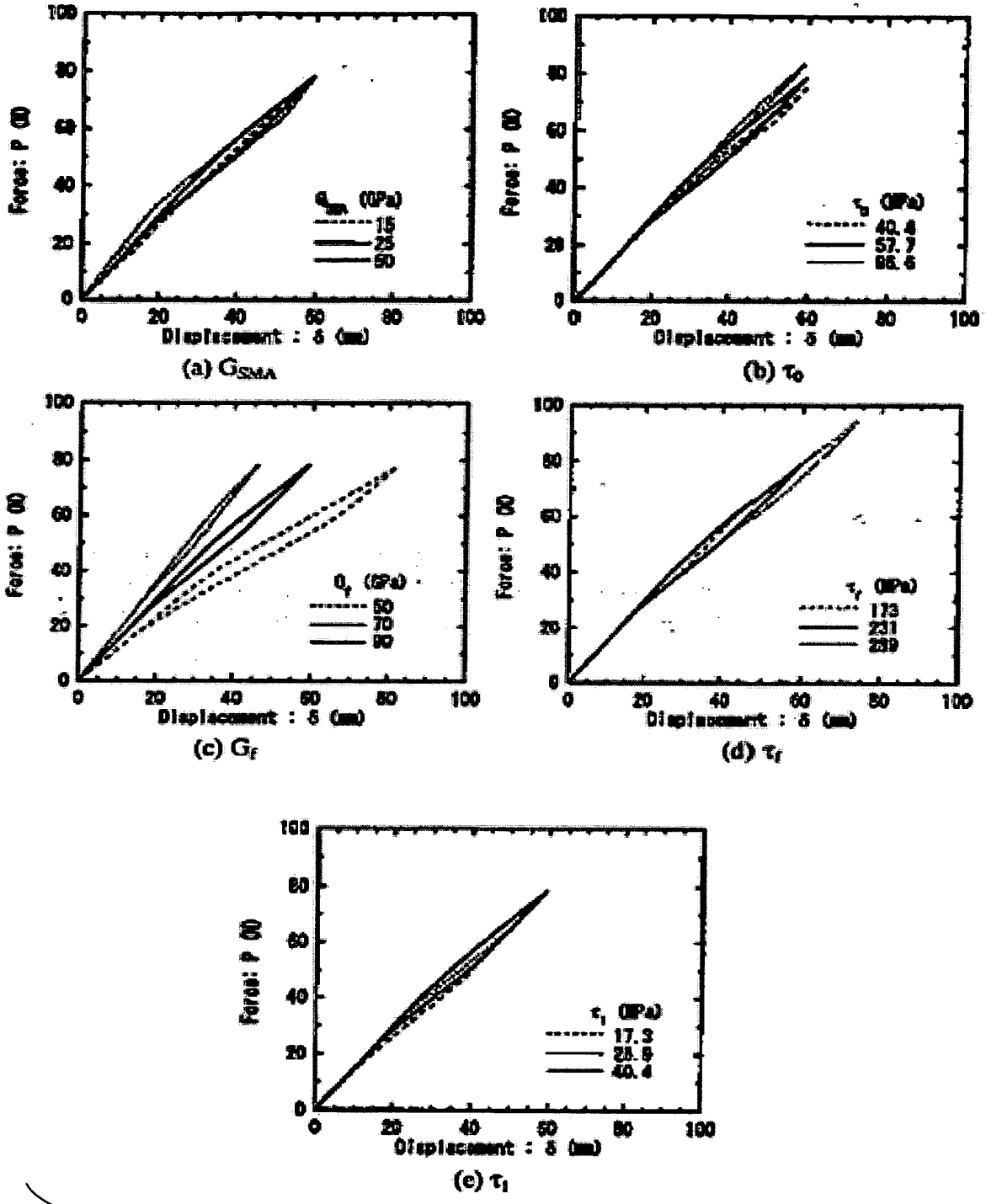


FIG. 37

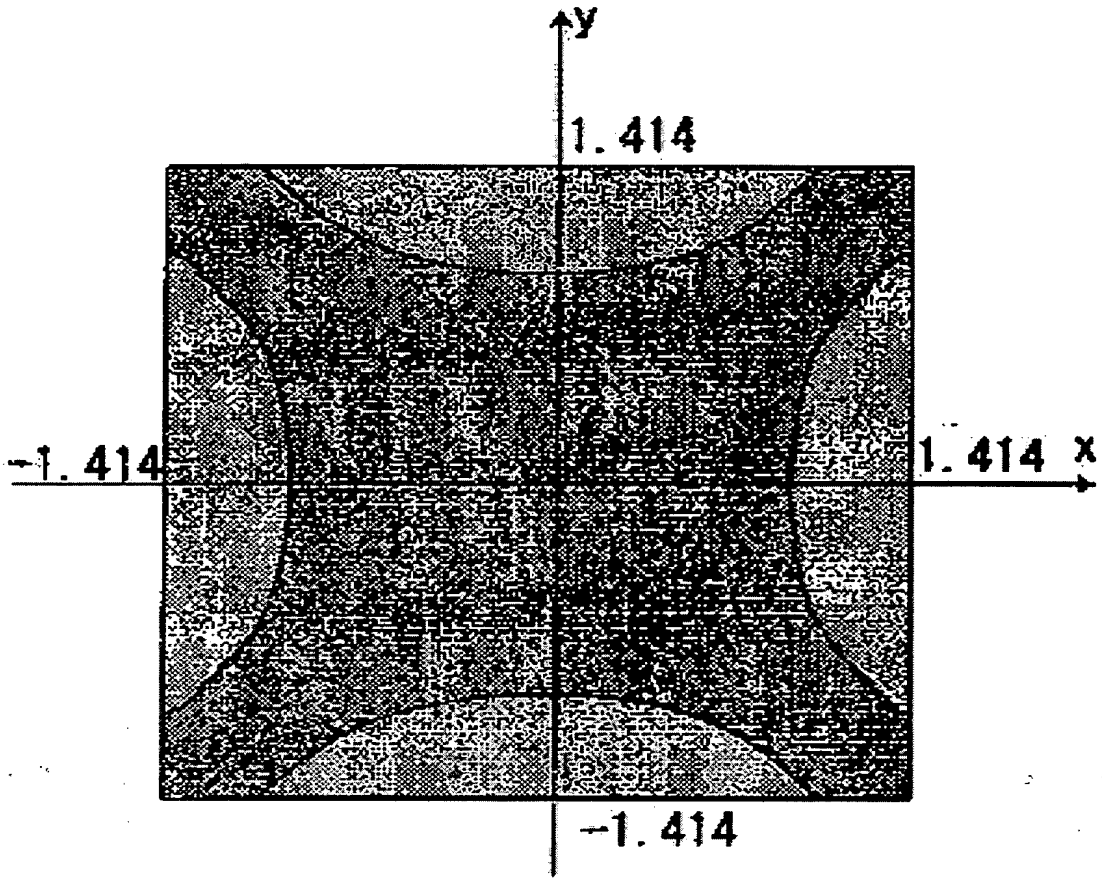

y
1.414
-1.414
1.414
x
-1.414

FIG. 38

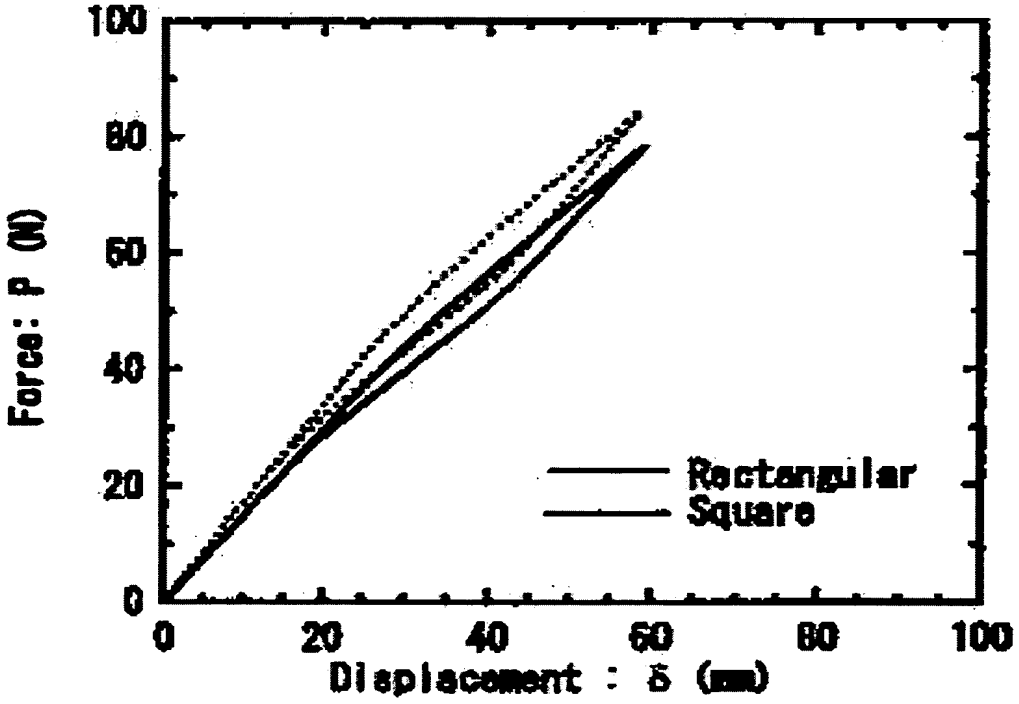

100
80
60
40
20
0
Force: P (N)
0
20
40
60
80
100
Displacement : δ (mm)
Rectangular
Square

FIG. 39

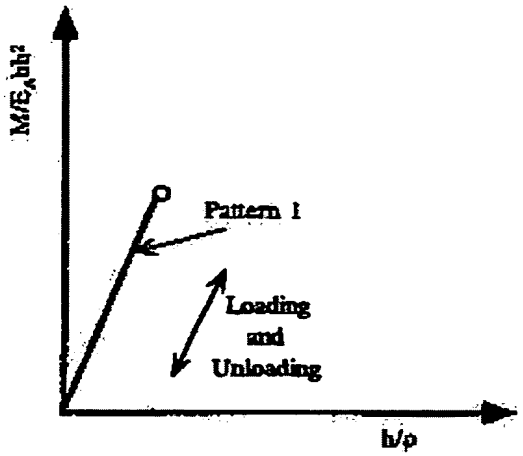


FIG. 40A

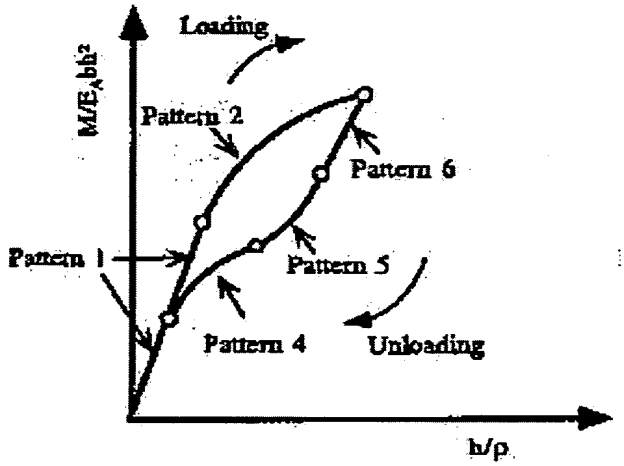


FIG. 40B

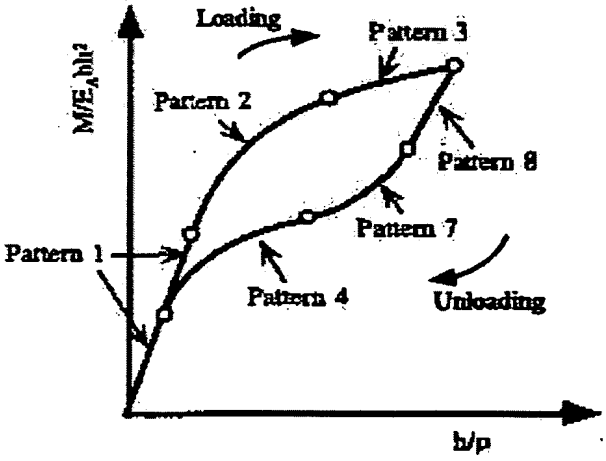


FIG. 40C